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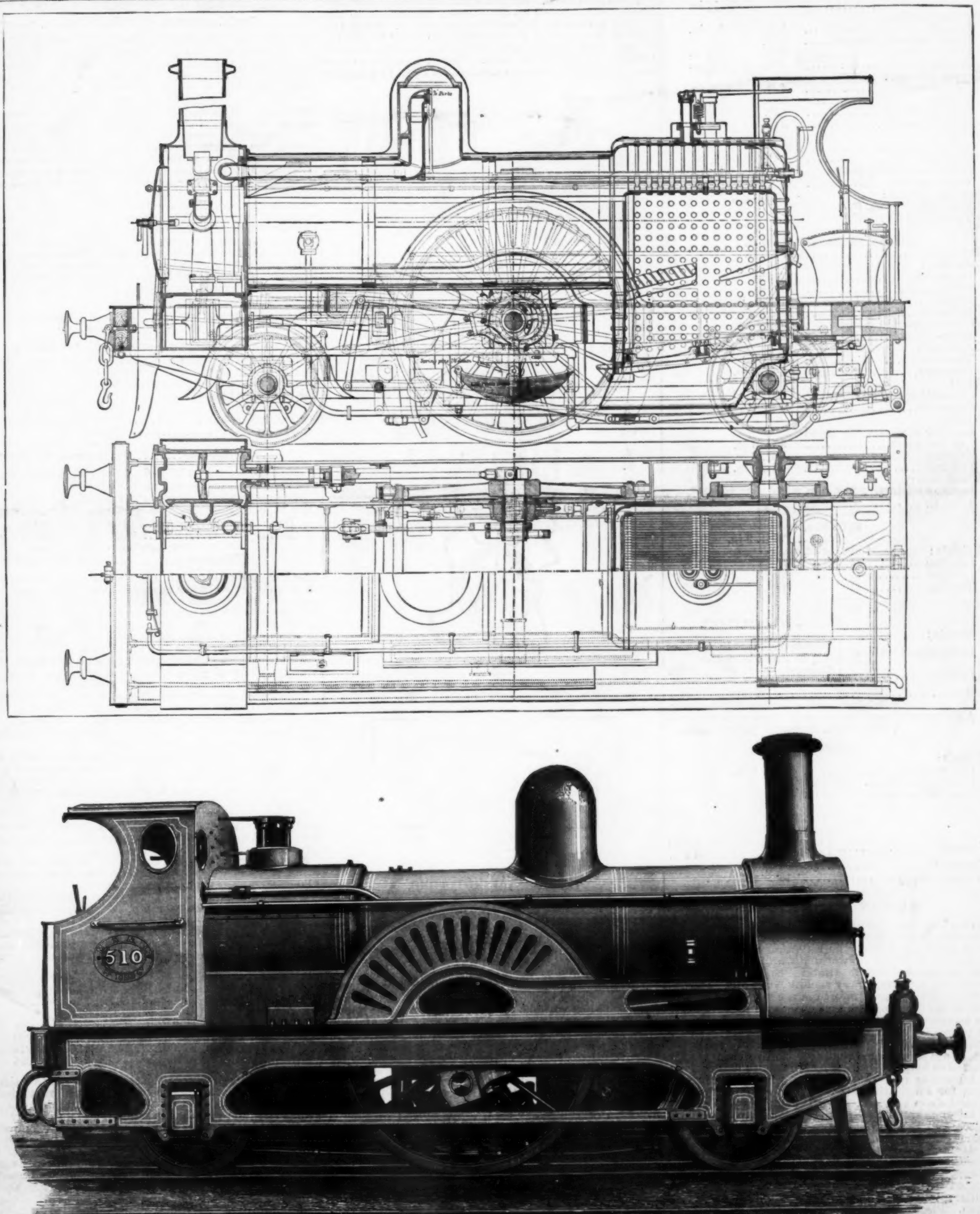


NEW EXPRESS ENGINE, MANCHESTER, SHEFFIELD, AND LINCOLNSHIRE RAILWAY.

EXPRESS ENGINE—MANCHESTER, SHEFFIELD, AND LINCOLNSHIRE RAILWAY.

WE illustrate one of several new engines of a powerful type designed by Mr. Charles Sacre, locomotive superintendent of this line, for working the fast and heavy traffic of the Manchester, Sheffield, and Lincolnshire Railway. It will be seen almost at a glance, says *The Engineer*, that the engine departs in several matters of detail from ordinary practice; and up to the present the results obtained have been, we understand, in all respects satisfactory. The arrangement of the wheel base is peculiar, the driving wheels being put further forward than usual. The dimensions of the engine are as follows:

Boiler:		
Diameter outside	3 ft.	11 in.
Length of barrel	11 ft.	6 in.
Thickness of plates (Yorkshire iron)		½ in.
Fire-box shell:		
Length	5 ft.	6 in.
Width between frames	4 ft.	½ in.
Height (front)	6 ft.	7⅜ in.
Height (back)	7 ft.	1⅝ in.
Copper fire-box:		
Length inside	4 ft.	10⅞ in.
Width	3 ft.	5½ in.
Height (front)	4 ft.	11¼ in.
Height (back)	5 ft.	5½ in.
Tubes:		
Number	195	
Diameter		1¾ in.
Length over tube plates	12 ft.	0 in.
Water spaces		¾ in.
Heating surface:		
Fire-box. 87 sq. ft.		
Tubes.... 1057 sq. ft.		
1144 sq. ft. Total.	1144 sq. ft.	
Grate area	17 sq. ft.	
Cylinders:		
Diameter	17½ in.	
Stroke	26 in.	
Ports	14½ in. by 1⅜ in.	
Exhaust	14½ in. by 3¼ in.	
Centers apart	6 ft.	
Inclination	1 in 12.	
Eccentrics:		
Throw	3⅛ in.	
Diameter	1 ft. 4 in.	
Rods:		
Connecting rod centers	5 ft. 7⅜ in.	
Eccentric	5 ft. 7⅜ in.	
Wheels:		
Leading diameter on tread of tire (steel)	3 ft. 8 in.	
Trailing	3 ft. 8 in.	
Driving	7 ft. 6 in.	
Wheel base:		
Leading centers... 7 ft. 9 in.		
Trailing .... 8 ft. 0 in.		
15 ft. 9 in. Total...	15 ft. 9 in.	

Weights:	tons.	cwt.
Leading	11	3
Driving	17	11
Trailing	11	18
	40	12
Total... 40 tons 12 cwt.		

Journals:	
Leading and trailing	Double-coned, 10 in. long by 6¼ in. and 5¼ in. dia.
Driving	Straight, 8 in. long, 9 in. diameter.
Axles	Wrought iron.
Axle-boxes	Driving, brass; leading and trailing, cast-iron; brass steps; all surfaces filled with Richards' patent metal.

TENDER.

Wheels:		
Diameter		3 ft. 9 in.
Centers (leading)	6 ft. 3 in.	
Centers (trailing)	6 ft. 3 in.	
	12 ft. 6 in.	
Total..		12 ft. 6 in.
Journals		Double-coned, 10 in. long; diameter, 4¼ in. and 5¼.
Capacity		3000 gallons.
Weight, empty		16 tons 13 cwt.

RATTAN LUBRICATORS.

FOR a long time the lubrication of the working parts of machinery was considered sufficiently provided for by an oilhole or oilcup, the attention to these being left to the engineer or workman using the machine, with the natural result that it was frequently neglected and the machinery rapidly worn out. In consequence of the many unfortunate experiences of this method, machine makers and users who consult their own interests have during recent years substituted for the primitive oilhole other lubricators, which either automatically supply a regulated quantity of the lubricant, or are so arranged that attention to them is only required at long intervals. To the former class belong the numerous and frequently very ingenious instruments for lubricating steam cylinders, and the mechanical drop lubricators for bearings; while among the latter may be classed the various cups for thick greases, and the arrangements for keeping up a continuous circulation of the oil on journals. To this latter class the system of lubricating by means of pieces of reeds or Indian rattan, introduced by a French firm, belongs. The oil is conveyed to the surfaces to be lubricated by atmospheric pressure, combined with the capillary action of the fine tubes which compose the rattan. Pieces of this cane are inserted into the brasses, and can be arranged in a great variety of ways, while the other ends dip into oil reservoirs to which the oil is returned again as it comes out at the ends of the journals; the circulation through the porous rattan being the more active, the quicker the shaft revolves. The rattan appears very suitable for this purpose, as it combines porosity with flexibility and toughness, being besides a bad conductor of heat, which prevents the oil in the pores from becoming thick in frosty weather. We illustrate three applications of the system to pedestals, loose pulleys, and vertical necks, as carried out by the makers.

Fig. 1 shows a shaft pedestal for long necks, with loose bearings of cast iron or gun metal resting in a pedestal of circular cross section fitted with an elliptical cap. As is seen, the pedestal and cap are spaced out to form a reservoir for the oil and a dust-guard over the collars, with a filling-in hole at one side, which permits the level of the oil to be seen, while a small screw at the bottom serves to draw off the oil when required. The cap fits solid on the pedestal, and excludes the dust. The bottom brass is perforated by a number of holes, six, eight, or more, into which the pieces of rattan turned to the exact diameter are inserted, while the other end, cut to a point, rests upon the bottom of the oil reservoir to prevent their getting out; or, in other cases, the holes are tapped, and the pieces of cane screwed into them. At first about an hour elapses before the oil is drawn up the tubes in the rattan to the bearing surface by the capillary attraction. When the shaft is then started, it draws the top layer of the lubricant with it and causes a gentle circulation, assisted by the atmospheric pressure. The oil brought to several parts of the journal extends over it, and on issuing

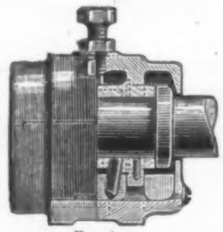


FIG. 1.

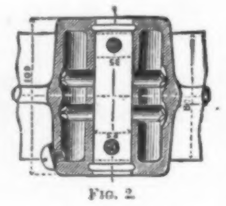


FIG. 2.

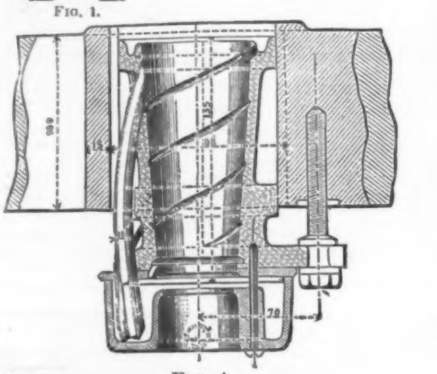


FIG. 4.

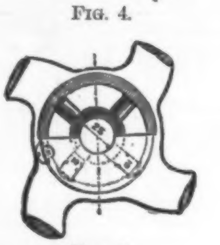


FIG. 3.

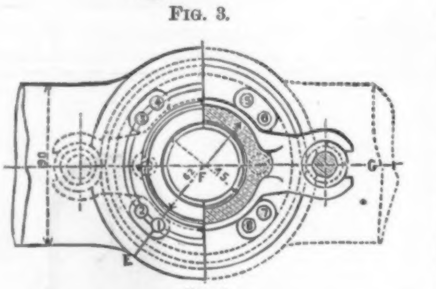


FIG. 5.

RATTAN LUBRICATORS.

at the ends drops into the lateral chambers extending over the shaft collars. The oil, if of a good non-oxidizing quality, lasts a very long time, as it is used over and over again. The whole of the shafting of the Rouen Industrial Exhibition was provided with such pedestals, as well as several high-speed machines.

The application of this system of lubrication to loose pulleys is shown by Figs. 2 and 3. The oiling of such pulleys is not without danger during working hours, as either the pulley or the shaft is revolving, and the oil applied in the ordinary manner through an oilhole, closed by a screw, lasts generally only a short time. The attention of engineers has been consequently for some time directed to automatic lubricators for loose pulleys, and several acting by centrifugal force are at present in the market, though these also require frequent refilling, as they have no return flow. The lubrication of the pulley shown by our illustrations is effected similarly to that of the pedestal, by a number of pieces of rattan inserted diametrically into the bore of the pulley, with their outer ends resting against the metal of the annular chamber cored out in the boss. This chamber is filled through a hole closed by a screw to the level of the under side of the shaft, or nearly so. The small pulley shown with a bore of 1 inch has been used for the change motions of spinning machines running at about 3,500 turns per minute, and has worked three months without renewal of oil, although with such a high speed a monthly revision is to be recommended. Other pulleys are stated to have worked on countershafts running at 150 to 300 revolutions per minute, for 15 months, with their first supply of oil, so that the extra cost of the pulley should be well paid for by the saving in oil.

For the lubrication of vertical shafts, the flexibility of the rattan has been made use of. As seen from Figs. 4 and 5, the pieces inserted zigzag in the bearing are bent to dip into a reservoir below, the return of the oil being secured by a collar or plate on the shaft, which throws the oil off over the inner edges of the reservoir. The neck shown has been used for a shaft running at 5,000 revolutions. At the Rouen Exhibition, Messrs. Tulpin Freres showed a hydro-extractor fitted with a neck of this kind, and a similar bearing, applied to a lapidary wheel, has been used for ten hours a day for several months without any heating. The three bearings shown by our engravings are the standard types adopted by the makers, but the arrangements can be modified in various ways to meet special requirements. —*Mech. World.*

ON THE INFLUENCE OF SAND ON THE STRENGTH OF CEMENT-MORTARS.*

By H. ARNOLD, of Wilhelmshaven.

AFTER observing that not only the quality of the cement used, but that of the sand also, is a very important factor in the composition of mortar, the author remarks that in the case of sand, beyond general vague directions that it must be "clean and sharp," no detailed classification of the characteristics of different kinds, with directions how to obtain in all cases a normal or standard sand of uniform quality, was generally available for practical purposes until the publication of the valuable results of experiments carried out at Wilhelmshaven since 1877, in building the second entrance to the harbor. Taking first the ordinary local (Dangast) sand, a standard or normal sand was obtained from it by washing and sifting in the prescribed manner. This mixed with cement in the regulated proportion of 1 cement to 3 sand gave a mortar whose tensile strength after seven days' setting was 5·93 kilogrammes per square centimeter (84 lb. per square inch), and after twenty-eight days 6·60 kilogrammes, which does not nearly approach the standard of 10 kilogrammes prescribed in all contracts. An experiment similarly conducted with Berlin normal sand gave as follows:

After 7 days	10·56 kilogrammes.
" 28 "	15·10 "

Being an increase of 43 per cent. in the interval, and 78 and 129 per cent. respectively higher than when Dangast sand was used. Specimens of Dangast sand and cement sent to the royal testing factory at Berlin gave the following results:

	After seven days.
Dangast sand	11·28 kilogrammes.
Berlin "	16·80 "
Difference	=49 per cent.

While experiments at Wilhelmshaven with Berlin sand and the very same cement gave with—

	After 7 days. Kilogrammes.	After 28 days. Kilogrammes.
Dangast sand	9·06	9·74
Berlin "	14·24	18·44
Difference	=57 per cent.	89 per ct.

The increase of strength from seven to twenty-eight days is therefore 32 per cent. for Berlin sand, and 7½ per cent. for Dangast sand, and from these and other experiments it is abundantly proved that "the quality of the sand not only exerts considerable influence on the first setting of the mortar, but also materially influences the progressive hardening of it."

Further trials with the same cement, but with the various kinds of sand specified below, were made in order to test the influence of the sand itself.

1. Dangast ordinary building sand, weight, 1·61 kilogrammes per liter (100 lb. per cubic foot); size of grain, very unequal and somewhat dusty; not very sharp.
2. Dangast sand No. 2. The same sand after further sifting; a somewhat smoother grain.
3. Dangast normal sand, prepared from No. 1 by washing and sifting. Weight, 1·506 kilogrammes per liter; grain, reddish and of uniform size; not very sharp. The microscope showed a rounding of the corners of the grains of quartz.
4. Wilhelmshaven common blue sand. Very sharp and extremely fine grain; contains hardly any soluble particles of mud and silt, and weighs 1·267 kilogrammes per liter.
5. Wangeroog sand. A somewhat coarser, but still a fine, very sharp clean sand, free from dust; weight, 1·47 kilogrammes per liter.
6. Berlin normal sand. A sharp, clean, whitish quartz sand of uniform grain, and weighs 1·547 kilogrammes per liter.

Mortars made with these kinds of sands, and the same cement, in the regulated proportion of 1 of cement and 3 of sand, gave the following tensile strength:

	After 7 days. Kilogrammes.	After 28 days. Kilogrammes.
Wilhelmshaven blue sand	7·15	9·40
Dangast normal "	8·78	11·10
" No. 2 "	8·98	11·04
" common building sand	11·60	13·00
Wangeroog sand	13·58	16·74
Berlin normal sand	17·60	21·94

These results show that the strength of mortars similarly made with the same cements, but different kinds of sand, depends on the coarseness and size of the grains of sand; and that in sands of equal size of grain that is the best whose grain is the coarsest. (Compare Berlin and Dangast normal sand in the above table, where the difference in the strength of the mortar is about 100 per cent.) In order to determine the influence of the size of the grain, comparisons were made with seven specimens of Dangast sand of various sized grains, and also with granite chips, the result always being in favor of the granite chips. This also came out of the experiments, viz., that in sands of equal coarseness of grain that is the best whose grain is largest. (Compare also, in the above table, Berlin normal sand with the Wangeroog sand, where the difference is about 30 per cent.) It was further established that coarseness of grain is a more important factor in the

* Translated for Abstracts of the Institution of Civil Engineers.

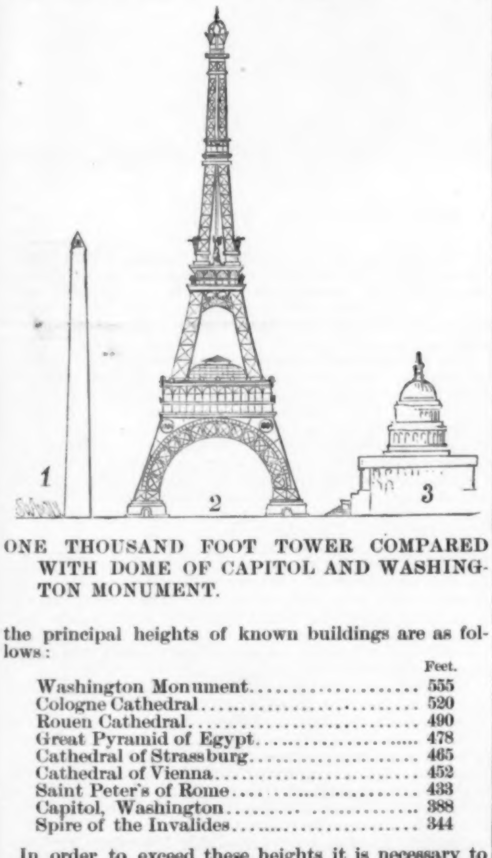
quality of a sand than the size of grain; and also that "a coarse sand free from dust gave better results than a fine sand of equal sharpness of grain." And further it was shown that sand containing uniformly sized grains is not always the best, since the ordinary Dangast building sand, which is somewhat dusty, invariably gave more satisfactory results than the sifted and washed Dangast normal sand of uniform size of grain. The author concludes by saying that, although different kinds of sand give materially different results in similarly prepared mixtures of mortar, it will not be justifiable in ordinary masonry to alter the prescribed proportion of cement and sand, viz., 1 to 3, unless the exact quality of sand employed is known, and he recommends:

1. That the normal sand of the Imperial Testing Station at Berlin should be declared officially to be the only prescribed normal sand as regards not only size, but also sharpness of grain, and that thereby a standard for the strength of cement and sand mortars should be established.
2. That in all notices regarding cement a comparison of results with this normal sand and with local building sands should be set forth.
3. That both the seven days' and the twenty-eight days' tests should be published, in order to obtain a scale of increase of strength in cement and sand mortars.

A ONE THOUSAND FOOT TOWER.

In January, 1874, the Scientific American gave the drawings and details of a one thousand foot tower which was proposed to be constructed by Clarke, Reeves & Co., in Fairmount Park, Philadelphia, Pa., near the Centennial Exhibition grounds. This idea was not carried out, but it has just been taken up again in France.

The example of the largest buildings that have been constructed up to the present shows that it is difficult, with materials in which stone plays the chief role, to exceed a height of from 490 to 525 feet, which may be considered as a limit rarely reached. In fact,



ONE THOUSAND FOOT TOWER COMPARED WITH DOME OF CAPITOL AND WASHINGTON MONUMENT.

the principal heights of known buildings are as follows:

	Feet.
Washington Monument	555
Cologne Cathedral	520
Rouen Cathedral	490
Great Pyramid of Egypt	478
Cathedral of Strassburg	465
Cathedral of Vienna	452
Saint Peter's of Rome	433
Capitol, Washington	388
Spire of the Invalides	344

In order to exceed these heights it is necessary to have recourse to the use of metal, which is the only material that permits not only of supporting the vertical reactions of the structure, but also of resisting the stresses of flexion resulting from the action of the wind, and which is considerable for great heights.

It is such an application that has permitted the authors of the project of which we are speaking to propose a monumental tower that they have no fear of carrying up to a height of 300 meters (984 feet), and which will thus be nearly double that of the highest monuments known. This height of 300 meters might again, if need be, be notably exceeded.

The tower is designed, in the mind of its projectors, to form part of the structures that will be erected on the occasion of the Universal Exhibition of 1889.

The metallic columns that have been constructed in recent times have usually reached a height of about 195 feet, and, in the present state of engineering art, there are no very serious difficulties in the way of reaching 260, and even 325 feet; but the question is entirely otherwise with the projected height of 984 feet, and in the detailed study there occur difficulties analogous to those that would be met with in the study of a bridge were it desired to pass from a span of 490 to one of 984 feet.

In fact, to cite but one special point, if we do not wish to multiply the uprights of the framework, we are forced to put in diagonal stays which exceed practical limits, and which at the base of the column reach lengths of more than 325 feet.

If, on the contrary, we multiply the uprights, we get a structure which is extremely heavy and of a deplorable architectural effect. It was necessary, therefore, to find a mode of construction which should limit the number of uprights, and nevertheless permit of doing away with the diagonal stays. This has been achieved in the present project, presented by Mr. G. Eiffel, the builder of the Garabit Viaduct. The framework of the tower consists essentially of four uprights that form the corners of a pyramid whose faces form a curved surface. The curve of such surface is determined by certain theoretical considerations of resistance to the wind that are characteristic innovations of the project,

A ONE THOUSAND FOOT TOWER.

and to which we shall have occasion to revert when the latter is definitely established.

Each of these uprights has a square section that diminishes from the base to the summit, and forms a curved latticework 49 feet square at the base and 16 at the top. The bases of these uprights are spaced 328 feet apart. They unite at the apex, and form a platform 33 feet square. These uprights are anchored to a solid masonry foundation, and are connected at different heights by horizontal platforms that serve as a support for vast halls which will be utilized for the different services that will be installed in the tower. The one on the first story, the flooring of which will be 230 feet from the ground, presents a superficies of about 5,400 square feet.

At the lower part, and in each of the faces, is a large arch of 230 feet opening, forming the principal element of the decoration. It gives the tower that monumental aspect which is indispensable for the purposes for which it is intended. At the apex there is a glass cupola from whence a vast panorama may be seen by the spectator. This part will be reached by elevators in the interior of the uprights, so arranged as to give absolute security. Aside from the attraction and monumental aspect that will be presented by this tower, the boldest manifestation of engineering art of our epoch, it will be susceptible of different uses that will be taught by experience, and among which we can already foresee the following:

1. *Strategic Observations.*—In case of war, there may be seen from the tower all the movements of the enemy within a radius of ten miles.

2. *Communications by Optical Telegraphy.*—In case of an investment, or of suppression of the ordinary telegraph lines, it will be possible from this elevated post to communicate by optical telegraphy with places at a considerable distance, such as from Paris to Rouen, for example, where the second observer will be placed upon a high hill.

3. *Meteorological Observations.*—An observatory at 984 feet above ground does not as yet exist, and a large number of questions, notably the direction and violence of atmospheric currents at such a height, has not yet been solved.

4. *Astronomical Observations.*—At this great height, the purity of the air, and the absence of the fogs that often cover the horizon of Paris, will permit of a certain number of observations that are now nearly impossible in ordinary weather in this city.

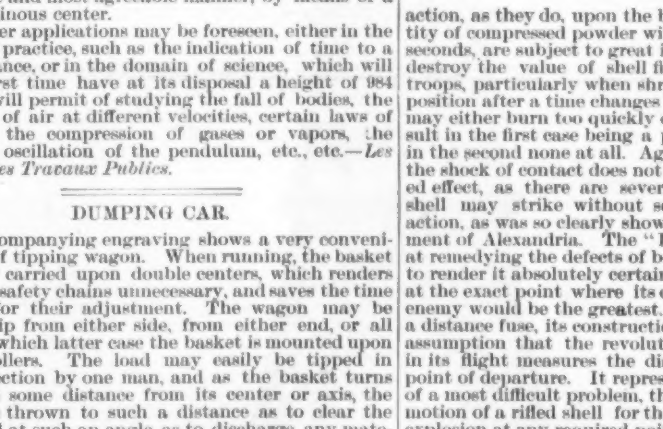
5. *Electric Lighting at a Great Height.*—By arranging electrical lights of sufficient power upon this tower, as has been done in certain American cities, it will be possible to obtain a general illumination whose advantages have long been recognized, but which has not yet been realized on a vast scale. In this way the entire exhibition and its approaches may be lighted in the completest and most agreeable manner, by means of a single luminous center.

Still other applications may be foreseen, either in the domain of practice, such as the indication of time to a great distance, or in the domain of science, which will for the first time have at its disposal a height of 984 feet that will permit of studying the fall of bodies, the resistance of air at different velocities, certain laws of elasticity, the compression of gases or vapors, the planes of oscillation of the pendulum, etc., etc.—*Les Annales des Travaux Publics.*

DUMPING CAR.

THE accompanying engraving shows a very convenient form of tipping wagon. When running, the basket is securely carried upon double centers, which renders the use of safety chains unnecessary, and saves the time required for their adjustment. The wagon may be made to tip from either side, from either end, or all round, in which latter case the basket is mounted upon friction rollers. The load may easily be tipped in either direction by one man, and as the basket turns on a pivot some distance from its center or axis, the material is thrown to such a distance as to clear the frame, and at such an angle as to discharge any material of ordinary tenacity without difficulty or assistance. As the basket when tipped does not rise above its original height, it need not be slung high in the first instance, and this advantage will be appreciated when it is remembered that the lower the wagon the easier it is to fill.

In the engraving the wagon is shown as tipping from the side. The double riding centers have already been referred to; the other two tipping centers describe arcs of circles similar to those of the teeth of a spur wheel of very coarse pitch. Briefly stated, the advantages claimed as resulting from the use of this system of tipping wagons are: The lowness of the top of the basket, and the consequent facility for loading; steadiness without any adjustment when running, and great angle of tip, which allows sticky materials to discharge without assistance.—*Mech. World.*



IMPROVED TIPPING WAGON.—MADE BY W. G. BAGNALL.

IMPROVED SHELL AND FUSE.

GENERAL BERDAN, the well known inventor of several military appliances in addition to the rifle which bears his name, has lately been carrying out a series of trials at the Turkish artillery butts at Tchatalja, with a new form of shell fuse, for which he claims many advantages over those at present in use, both "time" and "percussion."

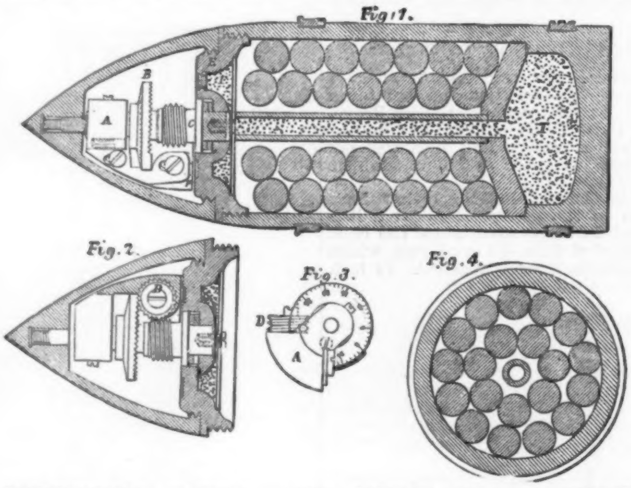
A correspondent of *Engineering* writes as follows: The first mentioned class of fuses, depending for their action, as they do, upon the burning of a certain quantity of compressed powder within a given number of seconds, are subject to great inaccuracies, which much destroy the value of shell fire when directed against troops, particularly when shrapnel is used. Fuse composition after a time changes its character, and the fuse may either burn too quickly or refuse to ignite, the result in the first case being a premature explosion, and in the second none at all. Again, with percussion fuses the shock of contact does not always produce the desired effect, as there are several positions in which the shell may strike without setting the mechanism in action, as was so clearly shown in the recent bombardment of Alexandria. The "Berdan" system is aimed at remedying the defects of both of these systems, so as to render it absolutely certain that a shell will explode at the exact point where its destructive effect upon the enemy would be the greatest. It is, properly speaking, a distance fuse, its construction being based upon the assumption that the revolution of a rifled projectile in its flight measures the distance traversed from its point of departure. It represents, in fact, the solution of a most difficult problem, the utilizat on of this rotary motion of a rifled shell for the purpose of effecting its explosion at any required point in its trajectory. The idea has been worked out in a very ingenious manner, as a glance at the sectional views in the adjoining column will show.

It is easy to understand that a projectile preserving in its flight the motion given to it by the rifling of the gun will cover a certain distance while making a certain number of turns. It is like a screw revolving upon its axis, and as with the propeller of a steamship, the number of revolutions made shows the distance run, and this independent of the speed, or any alteration of it that may have taken place while the registration has been going on.

The parallel, however, ends here, for whereas with the ship the shaft and propeller may revolve at any amount of rate of speed, she herself will remain steady, in the case of the projectile the whole is in motion. It is easy enough on board of a steam vessel to arrange for the shaft to register its revolutions, and to set other machinery in action when a certain number of revolutions have been made; but how to get a fixed point for the attachment of any sort of machinery, where all the parts are in motion, is an exceedingly difficult problem. This, however, is not the only difficulty the inventor has had to deal with.

The velocity of a projectile gives a number of revolutions per minute, which renders it necessary to arrange some contrivance by which the latter may be reduced to the measuring capacity of a dial plate of suitable dimensions for the size of shell.

These two difficulties have been overcome, the one by the employment of an inertia weight, which maintains its position under all circumstances, serving as a bearing for the central axis as well as a point of attachment for the index arrangement, and the other by making the driving wheel of the latter a compound endless screw.



IMPROVED SHELL AND MECHANICAL FUSE.

The shell revolves according to the rifling of the gun, making one turn, as it may be, for every five yards of distance traversed, while the weight remains hanging vertically. The central axis or driving screw revolves with the shell, the one end, C, being riveted into the diaphragm, separating the fuse compartment from the magazine, the other, as already explained, finding a bearing in the inertia block, A. The driving wheel, D, which gears into both the central axis and the index arrangement, as shown in Fig. 2, has twenty-five teeth, while the index is cut for fifty.

The teeth of the driving wheel, which is of some thickness, have, moreover, a screw cut across them, and by this contrivance 1,250 revolutions of the shell are reduced to one complete revolution of the index. In the present instance this would represent 6,250 yards, and the dial plate being graduated accordingly, each tooth moved forward would be equivalent to 125 yards of distance traversed.

The firing is effected as follows: A pin presses against the hub of the dial, in which there is a slot cut. When the dial has moved around the distance for which it is set, this pin springs into the slot, and is immediately pressed backward. The other end of the firing pin is provided with a roughened surface, which, under the action above described, comes in contact with a ring of fulminate placed in the diaphragm, and the explosion of the shell naturally follows.

General Berdan has carried his intended improvement of shell firing even beyond the fuse. As seen in Fig. 1, he places the bursting charge of his shrapnel shell at the rear of the bullets, with the idea of its not becoming ignited until the head of the projectile has been blown off by the action of the fulminates and the powder contained in the recessed ring at the back of the diaphragm. By this arrangement it is intended that the bullets should be blown out and scattered at the exact position before the enemy for doing the latter the most mischief. Referring to the diagrams, Fig. 1 shows a longitudinal section of the fuse and shell, Fig. 2 a section of the fuse showing the manner in which the index wheel, D, is geared, and Fig. 3 is the dial plate with the inertia weight, A, attached; C is the central axis or driving shaft, E the diaphragm, S the fulminate ring, P the firing pin pressing upon it, F the powder ring of the diaphragm, and T the bursting charge of the shell. Theoretically this fuse is perfect. Placed in a lathe, the mechanism works without the slightest hitch, the pin falling regularly for the distance set, and this while the fuse is revolving at a velocity far exceeding that which would be given to it on leaving a gun. Only private trials of this fuse have been made as yet—on the part of the inventor—with the view of testing the graduation of the dial plates, although they have taken place in the presence of a few Turkish officers. From what I have been able to learn in respect to the recent proceedings at Tchatalja, the shells, of which there were eighteen fired, all exploded at about the same distance from the gun, and the parts of one of the fuses which were picked up clearly showed that the firing pin had fallen into the slot as required. From this it would appear that General Berdan is on the road to success, although it will be necessary to prove by very exhaustive trials the accuracy of this system of fuses under all circumstances, before the present methods of igniting the bursting charges of shell are abandoned in favor of it.

TELEGRAPHS.

MR. A. L. TERNANT has recently published a second edition, in two volumes, of his work under the above title; and as a large number of recent apparatus has

FIG. 1.—AERIAL TELEGRAPHY.

FIG. 4.—MANGIN APPARATUS COMPLETE

FIG. 5.—FRENCH MILITARY TELEGRAPHER.

come to take a place alongside of their predecessors, it is truly a new work that we are about to review.

The first volume is divided into four chapters: optical telegraphy, acoustic telegraphy, pneumatic telegraphy, and carrier pigeons.

The Chappe telegraph heads the list. The simplicity of the arrangements, and the special circumstances under which the first applications of this were made, give the paragraphs in regard to it a very peculiar interest. The first application was decreed by the convention, as

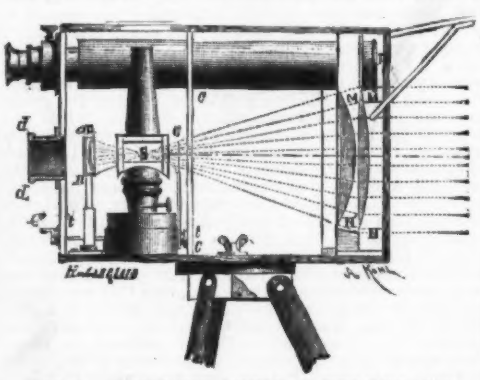


FIG. 2.—MANGIN'S OPTICAL TELEGRAPH.

well known, at a time when the enemy was investing the frontiers.

"This first line (from Lille and Loudun to Paris) was ready for operation in Fructidor of year II [August, 1794], and the circumstances under which the first telegram was announced to the Convention merit recital.

"The city of Conde had just been captured from the Austrians. The same day, that is to say, September 1, 1794, at noon, a telegram from the tower of Saint Catherines at Lille reached, station by station, the

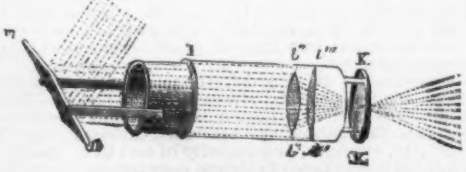


FIG. 3.—HELIOSTAT.

dome of the Louvre at Paris just at the moment the Convention was beginning its session. Carnot went up to the tribune and announced that he had just received the following news by telegraph: 'Conde is restored to the republic; the restoration took place this morning at six o'clock.' This news was received with a storm of applause, and there was only one cry, and that was in honor of the new invention that had been so brilliantly inaugurated for the honor and safety of the country."

So much said, let us pass over all that concerns maritime signals, semaphores, etc., and come to optical telegraphic apparatus properly so called, the principal of which are those of Mangin and Mance.

These two systems are in fact adopted at present, the first in the French army and the second in the English. Their creation is very recent. During the war in 1870, the Marseilles Committee on National Defense proposed to the government of Tours a system of luminous signals based upon the emission of short and long rays corresponding to the Morse alphabet, and with which communication could be had with Paris above the first line of investment. This proposition emanated from Mr. Ternant himself, who had had occasion to see a similar system operate in the Persian Gulf.

Some experiments were made at Marseilles, but, although the results were conclusive, the Committee could not decide in time, and events soon rendered impracticable a project that, sooner, would have been carried out.

At present, as we have above stated, the idea has made its way, and the Mangin apparatus is adopted in the army.

Fig. 2 shows a longitudinal section of it, and Fig. 3 gives the details of the heliostat designed to project the solar light. The disk, K K, contains an aperture in the center in order to allow the small solar image to be seen that is formed by the lenses, $l' l''$ and $l'' l'''$. A system of mirrors, $m\,n$ and $m\,n'$, serves to reflect the solar light, and a movable screen, when the apparatus is regulated, permits of the emission of the short and long flashes that translate one's thought.

However interesting this apparatus may be, and whatever the services that it is rendering and is capable of rendering, the Mance heliograph, shown in Figs. 6, 7, and 8, appears to us to be far preferable. As may be seen, it is extremely simple, and of a lightness that renders it truly portable. It consists of a circular mirror supported by two pivots that allow it to oscillate. The signals, which were at first made by hand, are now made by means of a Morse key that Mr. Stone has recently introduced.

The heliograph, in station, rests upon a tripod that supports a metallic base. At 40 or 50 feet from the apparatus, and upon the line of the corresponding station, are two sights, H and H' (Fig. 6), fixed upon a pole. One of these is of metal, and must be placed upon the line, which, starting from the center of the heliograph, ends at the opposite station. The other, which is of wood, receives the solar ray reflected by the mirror when the apparatus is at rest. In the morning or evening, when the sun is behind the operator, the angle becomes very obtuse, and the image of the spot loses its circular form. For great ranges it becomes necessary, then, to have a second mirror, whose very simple arrangement is given in Fig. 8. This apparatus weighs but 6 pounds, and now is in general use in India.

Thus closes the first chapter of the book. The second,

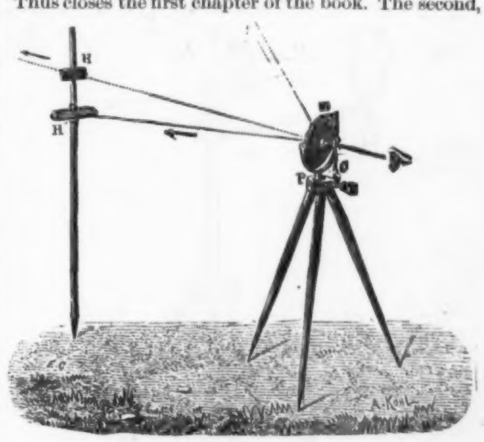


FIG. 6.—MANCE'S HAND HELIOGRAPH.

on acoustic telegraphs, has raised some objections. Mr. Ternant, in fact, has been reproached for considering the telephone as a telegraph, and for having intercalated it into his work. In our opinion, the classification of the author appears to be absolutely rational. Telephony having been developed, it is true, to such a point

FIG. 9.—ENGLISH MILITARY TELEGRAPHER.

as to constitute a science of itself, is none the less for all that a branch of telegraphy, and its place is fully indicated in a work like the one under consideration. Perhaps it might be well to change the place of this chapter, and bring it nearer to the electric telegraphs properly so called. The pneumatic system and transmission by pigeons might, in fact, precede instead of following; but these are criticisms of detail upon which we shall not dwell.

The telephone question in Mr. Ternant's work is

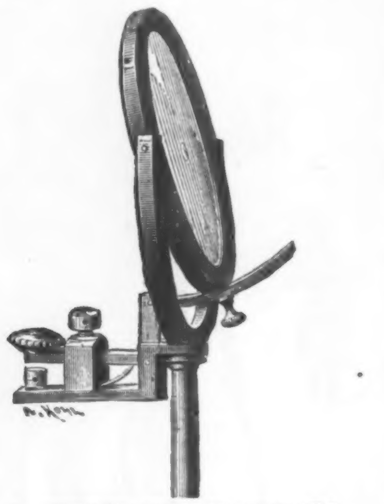


FIG. 7.—STONE'S HELIOGRAPH KEY.

treated therein in a special manner. The author has here devoted himself to showing how conductors are installed in cities, to explaining how exchanges of communications are operated in large centers, and to making known the attempts that have been made to suppress induction on the line. Especially are the labors of Dr. Herz treated therein with that clearness that appears in all parts of the book.

Finally come the pneumatic lines. The system of these is explained in all its details, and the two organizations, French and English, are described side by side as with the optical telegraphs. We should like to analyze this chapter more fully, but want of space prevents us; so, too, the portion relating to carrier pigeons is not that which presents the least interest.

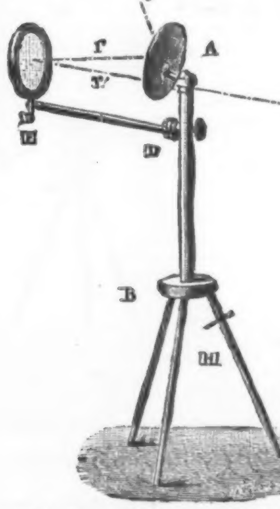


FIG. 8.—DOUBLE MIRROR HELIOGRAPH.

However, what we could say about it could not possibly give a sufficiently accurate idea. Mr. Ternant's book is one of those that should be read, and we doubt not that it will be.—*La Lumiere Electrique.*

THE ELECTRIC RAILWAY OF THE ROYAL COAL MINES OF ZAUKERODA.

THIS railway has been in operation since the fall of 1882, say two years. The line, which is established in the fifth gallery of the Oppel shaft, at 720 feet below the vein, serves for the carriage of all the coal mined therein.

The operation of this road up to the present day has been of the most satisfactory character, and has greatly interested those versed in the mining industry. It will be well, therefore, to examine its mode of construction, its prime cost, and its different advantages. We shall first show what were the general considerations that led to an installation of this kind.

I. GENERAL CONSIDERATIONS.

The fifth gallery of the Oppel shaft runs in a straight line through the mine in a southwest direction, and here are found the cars full of coal coming from the different secondary galleries. The work lasts sixteen hours, from 4 o'clock in the morning to 8 o'clock at night, and the rolling stock necessary for the exploitation is 660 cars. The large amount of carriage that is done in this gallery made it a more favorable place than any other to try mechanical traction. Among other very favorable conditions for making the trial cheaply was the double track that had already been laid. It was necessary, however, to choose between the different systems of tractions to be adopted. Traction by chains or cables was rejected at the outset on account of the steam engines that would have had to be placed near the fifth gallery, precisely where the cold air entered, and which would have proved prejudicial to ventilation. On another hand, the length to which power would have had to be transmitted by the cable was too great. Transmission by compressed air, through a cable or chain, was found no more practical, because of the little effective power that would be obtained thereby and the high cost of the installation. It was therefore decided to try electricity. A conference was held with Messrs. Siemens and Halske, in regard not only to the cost of the establishment, but also as to what the effective performance would be.

The guarantee averred that a minimum of power should correspond to a traction of 10 cars, each loaded with 12 bushels of coal (say a total load of 15,950 pounds), with a minimum speed of 6½ feet per second. The specification included the following *materiel:* a locomotive, a machine for generating electricity, and a steam engine for actuating it; 2,295 feet of double conductors, with the necessary insulators for fixing them in the gallery; 850 feet of cable for connecting the generator with the conductors; and a few duplicate pieces, the whole costing $3,500. Being given the cost and the guaranteed performance, the economy of the system over all others could be determined in advance.

II. ARRANGEMENT OF THE RAILWAY.

We shall divide the electric railway into three distinct parts: (1) The *generator*, or dynamo-electric machine; (2) the *conductors;* (3) the *locomotive.*

(1.) *The Generator.*—This is a Siemens dynamo of the D° type. It is driven by a vertical steam engine. The ratio of the pulleys is as 3½ to 1. The internal diameter of the motive cylinder is 7·8 inches, and the stroke of the piston is 9·8 inches.

(2.) *The Conductors.*—The conductors that carry the current from the generator to the locomotive are identical with those of the return current. It is impossible here to make the earth a conductor of the latter, since it would require a large surface of metallic contact by reason of the current's intensity. From the primary machine to the shaft, say for a length of 175 feet, the conductors are simple, naked copper wires, ¼ inch in diameter. In the shaft the conductor that leads the current is insulated, as shown in Fig. 7, where *a* is the copper wire, *b* and *b* India rubber insulators, *c* a leaden sheath, and *d* an outer covering of galvanized iron wire. This conductor is further protected against injury by a wrapping of tarred cloth.

The return conductor is likewise equally well insulated with tarred cloth, but is not surrounded with a sheath of galvanized iron wire or with guttapercha. These two cables are simply suspended in the mine, and are held at distances of 30 feet apart by iron hooks driven into the wall. Upon reaching the loading place they are connected with rails s, s^1, s^2, fixed all along the key of the arch of the principal gallery (Figs. 1 and 3). The current is taken up by the rails in order to be led to the locomotive, which latter, thanks to the arrangement devised by Messrs. Siemens and Halske, is capable of running backward or forward or of passing from one track to the other at will. To this end, a contact carriage slides along each conducting rail, and is so arranged that it can move in either direction. Two catches, h, h^1 (Figs. 5 and 6), hold it at the upper part, and the springs, b^1, b^2, b^3, secure a contact by bearing under the rail.

A copper cable covered with rubber is fixed to each of the two contact carriages by a joint, *g*, and afterward connected with the locomotive through the socket, *h*. In the beginning, these conducting cables effected the traction of the carriage, but, since they often broke, it became necessary to attach two short hemp cords to the carriages for drawing them.

(3.) *The Electric Locomotive.*—This is constructed symmetrically, that is to say, its running being reversible, it is provided at both ends with a seat for the engineman, and with maneuvering levers, commutators, etc. In this way the engineman is always seated in the rear, whatever be the direction in which the train is running, and can bestow his attention upon the track ahead of him. In front of him are the bell and signal-light. Within his reach are arranged two winches, one of which actuates the brakes, and the other the commutators that permit of opening or closing the circuit. This latter winch permits likewise of reversing the current in order to cause the receiving electric machine, and consequently that of the locomotive, to revolve in one direction or the other.

It is well to note incidentally that a breakage of the current is never produced abruptly. In fact, in such a case, sparks would be formed at the point of breakage that might melt the extremities; and, moreover, the electric machine might be quickly rendered unserviceable. The interruption must be gradual, and to effect this result increasing resistances are interposed in the circuit so as to notably decrease the current's intensity. In this way the last spark due to the breakage no longer presents any danger. The resistances consist of carbon crayons of relatively small section. The result is a heating of the crayons through the effect of the current's passage; although this is greatly reduced by the water into which the resistances dip. The boxes that carry the whole thing are arranged upon the top of the locomotive, in order to facilitate the replacing of the water that has been evaporated by the heat developed by the current.

The dynamo is placed lengthwise, and actuates one of the axles by means of gearings. It is of the same structure as the primary machine.

The dimensions of the locomotive are as follows:

Length between buffers	8 feet.
Width	2·6 "
Height	5 "
Weight	3,500 lb.

It is capable of developing sufficient power to haul 8 tons at a velocity of 7 miles an hour.

The cars have the following dimensions:

Length	5 feet.
Width	2 "
Height	3·25 "

The tare is 550 lb., and the load of about 1,050 lb. corresponds to 12 bushels.

III. OPERATION.

Formation and Running of the Trains.—The southeast track is set apart for loaded trains (Fig. 2), while the northwest one is used for those that return empty. Only one train is run at a time.

The effective length of the line worked is 2,035 feet, counting from the shaft in the gallery where the trains are made up to the extremities that are being mined. Beyond, the gallery has 2,360 feet of track.

To make up the trains, the guard near the shaft pushes the empty cars on to the track for empty trains, behind switch No. 1, immediately after they are unloaded.

At the other extremity of the line the train is made up by hauling the loaded trains coming from the different galleries immediately on to the track by means of horses. The same is the case with the cars descending from the shaft, S_3.

The locomotive, which hauls, or rather pushes, the loaded train leaves it as soon as it nearly reaches the principal shaft, and, running over switch No. 1, places itself behind the train. It then pushes the latter over the track set apart for empty trains until it reaches switch No. 3, by means of which it may again place itself behind a loaded train. The second switch is only used exceptionally; when, for example, there is too large a number of full cars running to allow the locomotive to reach the first switch. In such a case the train is made up behind the second switch, so that the locomotive, on maneuvering by means of the latter, can change track and place itself behind the empty train. Thanks to these arrangements, there is no need of turn-tables. Pushing is preferred to hauling because of the great saving in time that is obtained through not coupling the cars.

Signals.—At the head of the train, upon the first car, is mounted a red light, *l* (Fig. 1), as a warning to those who work in the mine. The locomotive signal lamp, l_1, lights up the track in the direction that the train is running. Its light is white.

On approaching the extremities of the gallery, the engineman rings the bill which the locomotive carries. Moreover, a special arrangement of electric bells puts him into permanent communication with the steam engine that actuates the dynamo. To this end, two conducting wires, placed upon insulators, r, r, r_2, along the gallery, are in the circuit of an electric bell and pile; but this circuit is only closed when the two wires touch. The engineman can sound the alarm by pressing the two wires together with his hand, and this too whatever be the position of the train.

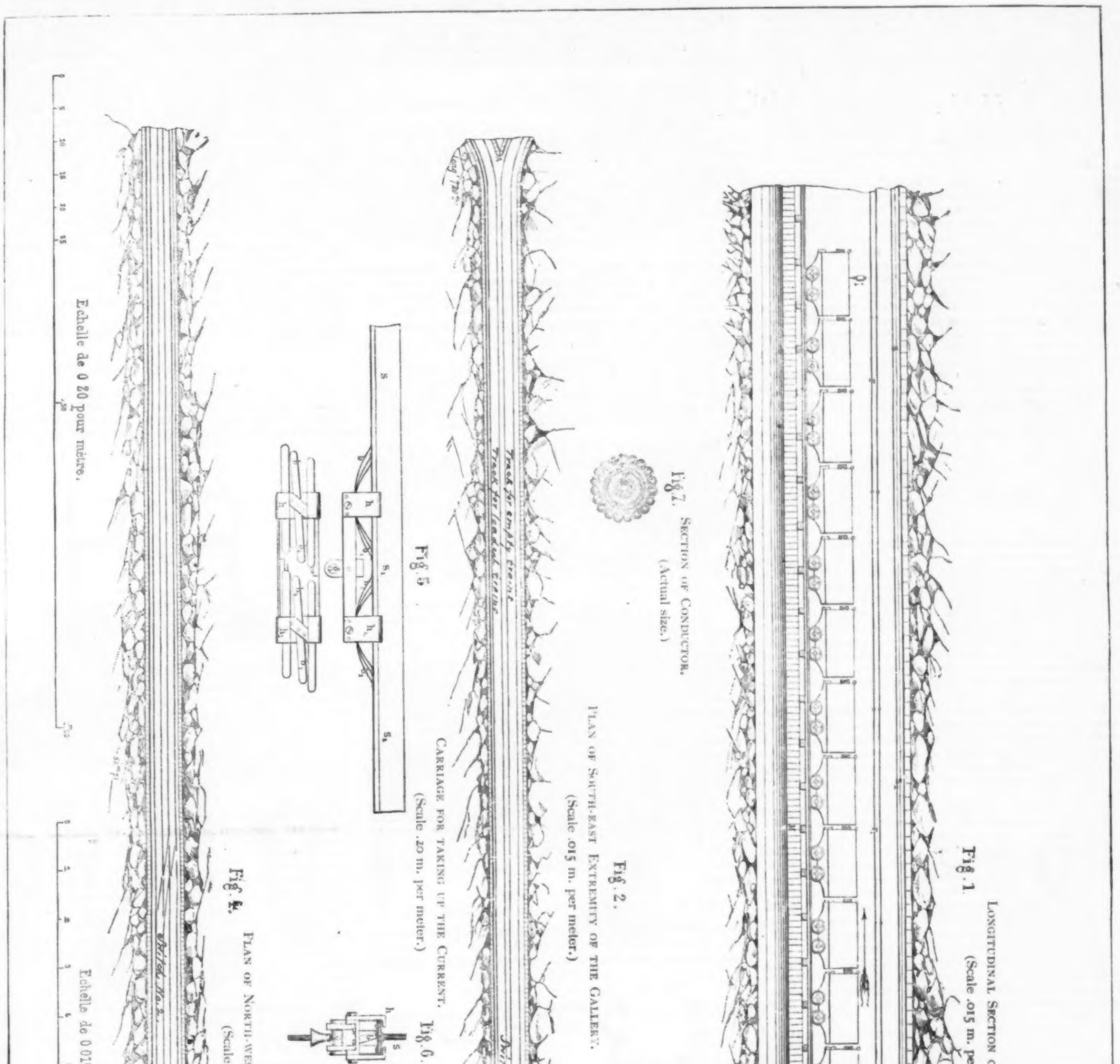
Personnel.—The men employed in the royal mines are divided into two gangs, and the same is the case with those of the electric railway. The morning gang works from 4 o'clock until noon, and the day gang from noon until 8 o'clock. No work is done during the night.

The force employed on the railway is two enginemen for the locomotive, and two to look after the steam engine. The work of the latter is not very complicated. The steam engine, in fact, is provided with a speed regulator whose effect they occasionally modify by the maneuver of a cock. In addition they are required to see that the friction brushes are kept in order, to keep the primary machine lubricated, and to keep the whole arrangement in a perfect state of cleanliness. The simplicity of the work permits of the employment of men who are disabled and who can be obtained at moderate wages.—*Annales Industrielles.*

ON REMELTING OF CAST IRON.

FROM trials conducted by Ledebur, it appears that cast iron is rendered suitable for foundry purposes, *i. e.*, to fill the moulds well and to yield sharp and definite forms free of flaws, to be cut with a chisel, and turned on a lathe, through a certain percentage of graphite, whose presence depends on that of carbon and silicium. Cast iron free of silicium yields on cooling the entire amount of carbon in the amorphous state, while presence of the former metal gives rise to the formation of graphite, and, consequently, causes a partial separation of carbon. Iron suffers on casting loss of graphite, assumes a finely grained texture, becomes hard and brittle, and is changed from gray to white. In view of the fact that samples of cast iron with equal percentage of silicium and carbon yield on casting a different product, it has become necessary to institute experiments as to the cause of this behavior. Samples of cast iron were therefore repeatedly melted, and thin sections of each melt examined; these sections exhibited a gray color, though less apparent than in the unmelted sample, and possessed sufficient softness to admit boring and filing. During these processes of fusion the amount of silicium, carbon, and manganese had been gradually decreased, and amounted to 12·7, 17·6, and 24·4 per centum for silicium in the three samples examined. It also was observed that the more manganese the iron contains the less readily the percentage of silicium is diminished; and since manganese is more subject to oxidation than silicium, it is capable to reduce silicic acid of the slag or lining to metal, and thus to augment the amount of silicium in cast iron. The percentage of carbon also suffers diminution by oxidation, which latter process is impeded by presence of manganese, a fact of some importance in melting of cast iron in the cupola furnace. An excess of manganese renders cast iron hard and brittle and imparts to it the properties to absorb gases, while an amount of 1·5 per centum, as found in Scotch iron, undoubtedly has the effect to produce those properties for which this iron is held in high repute. The amount of copper is not visibly altered by fusion, but that of phosphorus and sulphur slowly increased.

Experiments in regard to the relation between chemical composition and strength of the material have established the fact that a large amount of silicium, graphite, manganese, and combined carbon reduce the elasticity, strength, and tenacity of cast iron, and that a limited percentage of silicium counteracts the injurious influence produced by an excess of combined carbon. On remelting of cast iron, increase in tensile strength was observed, which attained its maximum in iron with a small percentage of silicium after the third, and in such with a large amount after the fourth melting. The increase in tensile strength was accompanied by a loss of silicium, graphite, and manganese coupled with a simultaneous augmentation of combined carbon. A fifth melting of the cast iron renders it hard, brittle, and white, through oxidation of silicium and subsequent lowering of the amount of carbon. On lessening the percentage of combined carbon, with formation of graphite, the injurious influence of the accessorial constituents of cast iron is diminished, especially that produced by the presence of phosphorus.—*Eisenhuettentechnik.*



ELECTRIC RAILWAY OF THE ZAUKERODA COAL MINES.

TANNIN.

By E. Dwight Kendall.

The name tannin is applied to a large class of organic bodies, familiar representatives of which are the tannins of nutgalls ($C_{34}H_{22}O_{22}$, a glucoside of digallic acid) and of sumac; similar astringent principles are found in oak barks, catechu, kino, divi-divi, gambier, myrobolans, hemlock, and many other barks, etc. This tannin combines with gelatine, in solution and in moist animal tissues, producing an insoluble substance; with ferric salts to form well known blue-black and green-black precipitates; with metallic salts and bases of salts, and yields definite compounds with many organic bodies.

The crude infusion of galls or sumac contains much extractive matter that serves no useful purpose in dyeing operations, the effective portions being gallotannic and gallic acids; and as the proportions of these valuable agents vary with the nature and quality of the tannic substances and the mode of extraction, it is desirable to have means of readily determining the quantity of both, and the relative proportion of each, contained in a given volume of a decoction. No simple process is known by which an exact determination can be made; the customary methods demand skill and practice, and the results obtained by different experienced manipulators are seldom identical, but they are sufficiently accurate for technical purposes.

Gallic acid ($C_7H_6O_5$) and digallic or gallotannic acid ($C_{14}H_{10}O_9$) are classed with the aromatic carbon compounds and may be regarded as derivatives of benzene, thus:

Benzene	C_6H_6
Benzoic acid	$C_6H_5.CO_2H$
Oxybenzoic acid	$C_6H_4(OH).CO_2H$
Dioxybenzoic acid	$C_6H_3(OH)_2.CO_2H$
Trioxybenzoic (gallic) acid	$C_6H_2(OH)_3.CO_2H$
Digallic (gallotannic) acid	$C_6H_2(OH)_2—CO—O—CO—C_6H_2(OH)_2$

When gallotannic acid is boiled with dilute acids or alkalies, it is converted into gallic acid ($C_{14}H_{10}O_9+H_2O=2C_7H_6O_5$); and by heating dry gallic acid, it is resolved into carbon dioxide and the triatomic phenol, pyrogallol: $C_7H_6O_5=CO_2+C_6H_6O_3$. Gallotannic acid also yields pyrogallol when heated, but only at a high temperature, say 250° C., while gallic acid is wholly decomposed at 185° C., with sublimation of the pyrogallol. A new quantitative method might perhaps be found by exploring in this direction, the gallotannic and gallic acids to be determined by the amount of pyrogallol obtained.

An analytical process, first practiced by Sir H. Davy, consists in precipitating gelatine from its solution by the tannic infusion, and weighing the dried resulting compound; it is not satisfactory, because it is difficult to thoroughly wash and dry the precipitated spongy mass, and gelatine unites with matters other than tannin.

Another method is to force the solution of tannin through rawhide by compressed air or mechanical appliances. In Muntz's tannin-testing apparatus the pressure is produced by means of a large screw. With this instrument, a small hydrometer, graduated for this use, and known as the tannometer, indicates the relative densities of the liquid before and after the percolation. To obtain the percentage of tannin, the difference of degrees is multiplied by 40, if the infusion contains 2½ per cent. of tannin-yielding substance; by 20 if 5 per cent.; by 10 if 10 per cent.; and by 5 if 20 per cent. If the tannometer indicates 2·8 in the solution, and 1·3 in the filtrate, the difference, 1·5, multiplied by 40, if 2½ per cent. has been used, shows that the tannic substance contains 60 per cent. of tannin; multiplied by 20, if 5 per cent. has been used, gives 15 per cent. of tannin. Allowance must be made for matters that are not tannin, and the pieces of hide used in confirmatory tests should be similar to the first, in all respects.

Prud'homme's process (Bull. Soc. Chim., 2, xxi.) consists in precipitating from a standard solution of methyl-green a part of the color, by a given volume of the tannic infusion, and determining the remaining coloring matter with a solution of chloride of lime. Solutions of the color and of pure gallotannic acid are first used to standardize the bleaching salt. To a given volume of the standard solution of coloring matter is added a solution of a given weight of pure gallotannic acid; the precipitated lake is separated by filtration; the proportion of remaining aniline color shown by the chloride of lime, and the process being repeated with a given volume of the tannic infusion under examination, the percentage of tannin may readily be calculated.

E. Schmidt (Bull. Soc. Chim., 2, xxi.) estimates tannin by precipitation with lead acetate. Dissolve 50 grammes normal precipitate in 400 grammes of alcohol; filter, and add water to make 1 liter. Dissolve 1 gramme pure gallotannic acid in 40 grammes alcohol; filter, and add water to make 100 c. c. To 10 c. c. of this tannic solution add 20 c. c. of water; heat to 60° C.; add lead acetate, from the burette, until precipitation ceases and potassium iodide shows a trace of free lead salt. Treat a suitable weight of the tannic substance to be examined, with hot water; filter the infusion, and evaporate to dryness; dissolve the residue in 40 grammes of 92 per cent. alcohol; filter, add water to make 100 c. c., and filter; the solution thus obtained is supposed to be free from natural resinous and gummy matters, but accompanying organic acids and extractive matters, which are also precipitated by lead acetate, render necessary additional operations to determine the proportion of such bodies. The affinity of lead oxides and salts for various forms of organic matter has hitherto prevented their adoption for exact work in estimating tannin, and it does not appear that this disadvantage has been obviated in Schmidt's method; a better reagent is tartar emetic (potassio-antimonious tartrate), which precipitates tannin from neutral and acid solutions, and is adopted for that purpose in several volumetric processes. By dissolving 2·611 grammes of tartar emetic in 1 liter of water, we have a standard solution, c. c. of which precipitates 0·005 gramme of gallotannic acid; addition of ammonium chloride or neutral ammonium acetate facilitates separation af the precipitate. A standard solution has been recommended containing 6·73 grammes of tartar emetic in a liter, the treated tannic infusion to contain not less than 0·1–0·3 gramme of real tannin; in either case excess of reagent is indicated by hydrogen sulphide, after separation of antimonious tannate.

Lowenthal's method of estimating tannin is as follows; prepare the following solutions:

1. Potassium permanganate, 1 gramme per liter.
2. Potassium sulphindigotate (an indigo-carmine), 6 grammes, and concentrated sulphuric acid, 50 grammes per liter.
3. Oxalic acid, 10 grammes per liter.
4. Gelatine, 25 grammes; water, 1 liter, saturated with refined common salt.
5. Saturated solution of common salt, 1 liter, to which add concentrated hydrochloric acid, 50 c. c. To standardize the permanganate, add a little hot water, slightly acidulated with sulphuric acid, to 10 c. c. of the oxalic acid solution, and drop in permanganate from burette, with stirring, until a faint permanent tinge of pink is perceptible; this should require about 50 c. c. The indigo solution should be so adjusted that about 1·5 c. c. is bleached by 1 c. c. of the permanganate.

Estimation of tannin: 1 to 25 c. c. of the indigo solution, in a white porcelain vessel, add water to make about ¾ liter; with constant stirring, the standard permangate solution is to be slowly added, toward the last, drop by drop, until the color changes to yellow; the value of the permanganate being noted, mark it A.

2. Mix 10 c. c. of the filtered decoction of tannic substance with 25 c. c. of the indigo solution and add permanganate, as before; note volume consumed and mark B; if B exceed 25 c. c., use a smaller quantity of the tannic solution, and make due allowance in the calculation.

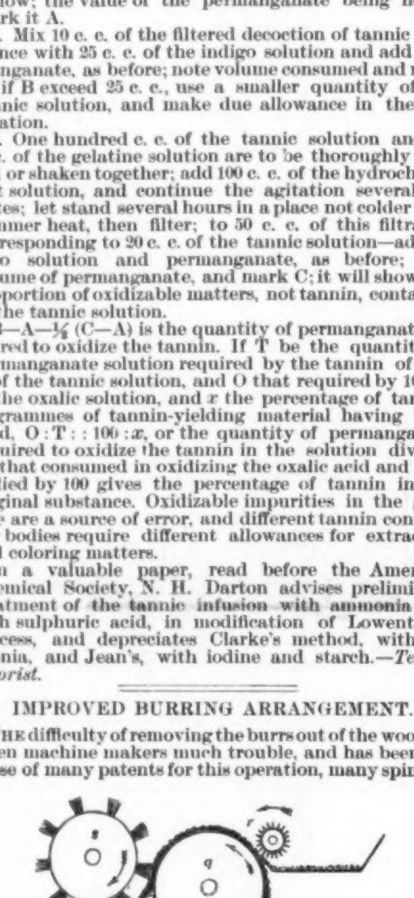
3. One hundred c. c. of the tannic solution and 50 c. c. of the gelatine solution are to be thoroughly stirred or shaken together; add 100 c. c. of the hydrochloric salt solution, and continue the agitation several minutes; let stand several hours in a place not colder than summer heat, then filter; to 50 c. c. of this filtrate—corresponding to 20 c. c. of the tannic solution—add indigo solution and permanganate, as before; note volume of permanganate, and mark C; it will show the proportion of oxidizable matters, not tannin, contained in the tannic solution.

B—A—⅕ (C—A) is the quantity of permanganate required to oxidize the tannin. If T be the quantity of permanganate solution required by the tannin of 10 c. c. of the tannic solution, and O that required by 10 c. c. of the oxalic solution, and x the percentage of tannin, 10 grammes of tannin-yielding material having been used, $O : T :: 100 : x$, or the quantity of permanganate required to oxidize the tannin in the solution divided by that consumed in oxidizing the oxalic acid and multiplied by 100 gives the percentage of tannin in the original substance. Oxidizable impurities in the gelatine are a source of error, and different tannin containing bodies require different allowances for extractive and coloring matters.

In a valuable paper, read before the American Chemical Society, N. H. Darton advises preliminary treatment of the tannic infusion with ammonia and with sulphuric acid, in modification of Lowenthal's process, and depreciates Clarke's method, with cinchonia, and Jean's, with iodine and starch.—*Textile Colorist.*

IMPROVED BURRING ARRANGEMENT.

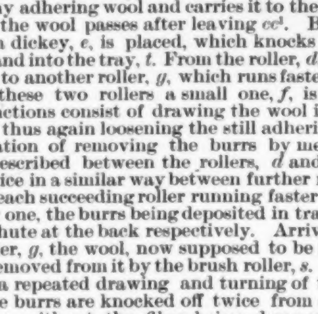
The difficulty of removing the burrs out of the wool has given machine makers much trouble, and has been the cause of many patents for this operation, many spinners



considering that the mechanical abstraction of the burrs is more favorable to a good quality of wool being obtained than the chemical process of extracting. The arrangement which we illustrate has been patented by a machine maker in Germany who has devoted much attention to the carding of wool, and it can be used separately as a special machine or attached to a carding engine. A represents the end of a creeper which brings the wool to the apparatus; from this it passes between two pairs of feed rollers, bb^1 and cc^1. These feed rollers are covered with saw teeth set spirally, a groove being cut between each two rows, and the rollers are so geared that the teeth of the upper run in the grooves of the lower one. The rollers in each pair make the same number of revolutions, but as their diameter is different, it follows that the larger one has a greater circumferential velocity, and consequently the wool is stretched and the burrs partially rubbed off. The speed of the rollers, cc^1, is double that of bb^1, which again produces a drawing of the wool. Above c^1 a stripper, c^2, is placed, which cleans c^1 from any adhering wool and carries it to the roller, d, on which the wool passes after leaving cc^1. Before the roller, d, a dickey, e, is placed, which knocks the loose burrs off and into the tray, t. From the roller, d, the wool passes on to another roller, g, which runs faster than d; between these two rollers a small one, f, is situated, whose functions consist of drawing the wool in its passage, and thus again loosening the still adhering burrs. The operation of removing the burrs by means of a dickey, described between the rollers, d and g, is repeated twice in a similar way between further rollers, k, n, and g, each succeeding roller running faster than the preceding one, the burrs being deposited in trays, u and v, and a chute at the back respectively. Arrived at the upper roller, g, the wool, now supposed to be free from burrs, is removed from it by the brush roller, s. There is therefore a repeated drawing and turning of the wool, so that the burrs are knocked off twice from each side of the fleece without the fiber being damaged by the rollers, since their action is always in the direction of their length, and they are constantly being loosened.—*Textile Man.*

WALLICH'S CONDENSER.

Dr. G. C. Wallich has patented an improved condenser, intended to obviate the difficulty which has hitherto been experienced in adequately illuminating objects having considerable depth, and more especially



when examined in the binocular microscope and with high power objectives. It extends the range in depth through which more or less transparent objects may be distinctly seen; and, when used with the binocular, facilitates the production and increase of true stereoscopic effect. The specialty of the improvement consists in the employment of a truncated cone of glass, in combination with one or more lenses capable of being adjusted with respect to one another. The conical surface is highly polished, so as to constitute an internally reflecting surface, the cone having such an angle as to produce total reflection.

In the figure, A is the cone mounted in a cell, D, and having a lens, B, attached to its larger end by transparent cement. C is a second larger lens, and mounted in suitable fittings, E and F, by which its distance from B can be adjusted so as to produce various effects. As improved effects may in many instances be produced by preventing the admission of light into the condenser from one or other side of the lens, C, a shutter, G, is added, pivoted at the circumference of the cylindrical fitting, F[1], by a screw, S, which shutter can be set in any required position by moving the knob, T, or by rotating the entire condenser in or by its fittings. For the purpose of producing various effects of illumination, diaphragms are also used furnished with openings of various shapes and sizes, placed either between the lenses B and C, or in front of the smaller polished transmitting end of the catadioptric cone, A. —*Jour. R. Mic. Soc.*

ETHER-SPRAY FREEZING MICROTOME.

By William Ruherford, M.D., F.R.S., Professor of Physiology in the University of Edinburgh.

During the thirteen years that have elapsed since I invented the freezing microtome, the method of freezing has come into general use as an aid to microscopical research in physiology and pathology. It has also become of much service in aiding the practical study of these subjects, especially when they have to be taught to large numbers of students. The original ice and salt freezing microtome described by me in the *Journal of Anatomy and Physiology* for 1871, vol. v., was somewhat faulty. The improved form of the instrument (Fig. 2) described by me in *The Lancet*, 1873, vol. ii., has been constantly used in my laboratory since that time. We have no difficulty in making with it from four to five hundred sections of the retina, kidney, or other organ, in the course of an hour. When large numbers of sections are required, it is, I think, always advisable to use a mixture of ice and salt as the freezing agent, on the ground of economy, and also because *large* pieces of tissue can be frozen quickly by it and kept frozen any length of time. We made a fair trial of the ice-freezing microtome devised by Williams and made by Swift of London, in the hope that its large freezing-box and method of regulating the thickness of the sections might still further expedite the process of section making, but after a time we gladly returned to the use of my instrument, as more convenient and more reliable.

The first microtome in which ether spray was used as the freezing agent was invented by Dr. Bevan Lewis, and described in the *Journal of Anatomy and Physiology* for 1877, vol. xi. The principle of the ether-spray microtome is excellent when only a small number of sections are required, and the circumstance that the freezing agent is always at hand renders it very convenient; but it is not suitable when a thick piece of tissue is to be frozen, and many sections made. I have found that even the modified ether-spray microtome described by Dr. Lewis in his work on the "Human Brain" (Churchill, 1882) leaves room for improvement. Eighteen months ago I added to my ice microtome an ether-spray apparatus for freezing, so that the instrument may be used as an ice microtome at one time and as an ether-spray microtome at another. (Fig. 1.) As the combined instrument is less costly than two separate instruments, and as the ether-spray arrangement differs in some particulars from any hitherto invented, I have thought that an account of it might

help some of the readers of *The Lancet* in carrying out their microscopical studies of normal and diseased tissue; and I may further help those who finished their medical studies before the freezing microtome was invented, by briefly giving the chief details that must be attended to in using the instrument.

Preparation of the Tissue.—As a rule, the tissues should be steeped in the usual hardening agents mentioned in the books for three weeks or a month before they are sliced in the microtome. The prepared tissue should then cut into pieces of desirable size and shape, and if it has been immersed in alcohol, every trace of that reagent must be removed by placing it for about six hours in a large jar of water. It is then transferred to a thick solution of gum arabic (gum one part, water two parts), in which it is left over-night, so that the tissue may be thoroughly permeated by the gum, to prevent it from becoming crystalline when frozen.

Use of the Microtome with Ether Spray.—The instrument is arranged as shown in Fig. 1. The tissue, which should be more than a third of an inch thick, is laid on the roof of a zinc box, Z, and covered with gum. Ether, which must be anhydrous, is then blown from the bottle, O, by the elastic bellows, N, against the lower surface of the zinc plate. The condensed ether flows down through the tube, P, and is collected in a vessel. The spray-producing tubes, T, can be readily pulled out of the slot under Z for examination. The tissue is soon frozen, and it remains frozen for about five minutes in a cool room, without any further production of spray. The elastic pump can easily be connected with a sufficiently long piece of elastic tubing, and arranged on the floor in such a manner that, after the tissue is frozen, the freezing can be maintained by working the pump at intervals with the foot, thus leaving the hands free for the process of section making. The zinc box on which the tissue is laid is insulated by vulcanite from the brass cylinder worked by the screw below it, and it is so made that, while ether is economized, a low temperature is obtained for a considerable time.

Use of the Microtome with Ice.—The glass plate, L, is unscrewed. The supports, M and M', the tubes, T, the ether bottle and bellows are removed· Z is unscrewed, and the plug, K, screwed in its place, and sunk deep in the well. The glass plate, L, is then screwed on the brass plate, B, and the instrument is ready for use (Fig. 2). Snow or finely pounded ice and salt are alternately placed in the freezing box, C, in small quantities, and stirred round the well with a piece of wood. A cork is placed in the tube, H, and removed only when the freezing box becomes full of water. Gum solution is poured into the well, and the tissue introduced, after a layer of ice has formed around the interior of the well, so that there may be no danger of any part of the tissue being without an envelope of frozen gum. The mouth of the well should then be covered with a thin sheet of gutta percha, and a flat leaden weight placed on it. The whole instrument should then be enveloped in a thick flannel, or some similar cloth, until the freezing is complete.

THE MICROTOME ARRANGED FOR FREEZING WITH ETHER SPRAY.

When arranged as shown in Fig. 2, the instrument can be used for the old method of embedding a tissue in melted paraffin and similar substances. In my laboratory the cutting of tissues by any but the freezing method has for years been abandoned in all cases excepting when sections are to be made without a machine. A great advantage resulting from the use of the method of freezing is that the embedding agent is readily got rid of by throwing and steeping in water for a time, leaving the most delicate tissues uninjured, and unencumbered by pieces of the embedding agent, as is the case when any embedding agent similar to paraffin is employed. Another important point is that the various methods for hardening the tissues so that microscopic slices of them may be sufficiently coherent for manipulation need not be pushed to the extent that was necessary when the tissue had to be cut embedded in paraffin. Consequently, finer preparations can now be obtained, and with an ease and certainty formerly unknown.

In making the sections with the above instrument, the knife is pushed on the glass plate at a right angle across the well. I am aware that with this arrangement the knife does not remain sharp so long as is the case when it is not glided on any surface, but is supported at one or both ends of the blade by some framework. But I find it of great advantage to have the knife held in the hand, so that it may be readily lifted, and the sections quickly brushed with a goat's-hair brush into a basin of water, or, in the case of the embryo, quickly drawn one by one from the knife laid flat upon a glass slip. Each section can thus be readily floated from the knife into a pool of water on the glass slip, so that every part of it is kept *in situ*. This ready handling of the sections in the mass or singly is impossible with the microtomes devised by Williams and Roy. Commonly the sections are brushed from the knife into a large jar of water, into which the gum diffuses from them. At the end of half an hour or so they are collected with a straight needle in small numbers at a time, and transferred to a second jar of water, in which they are left for the same time. They are then transferred to a third jar, and at the end of half an hour they are transferred in the same way to a stoppered bottle containing methylated spirit, in which they are kept till required for staining and mounting.

The indicator (E, Fig. 1), though useful to the beginner in helping him in making sections of uniform thickness, is soon abandoned, as the manipulator soon learns to regulate the extent of the screw's motion by his sensation. The knife suitable for my instrument requires to be specially made. Both instrument and knife are made by Gardner, instrument maker, South Bridge, Edinburgh.—*Lancet.*

THE MANUFACTURE OF SUGAR OF MILK IN SWITZERLAND.*

By J. KUNZ.

1. THE CHEMISTRY AND COMMERCE OF MILK-SUGAR.

SUGAR of milk is a regular constituent of the milk of all mammals. Horse's and ass's milk usually contains 6 per cent. and over, cow's, goat's, and sheep's milk between 4 and 5 per cent., and sow's milk 3 per cent. Woman's milk contains less albuminoids and fat than cow's milk, but a larger proportion of sugar of milk; on an average, 6 per cent.

Owing to its comparatively difficult solubility and its great readiness to crystallize, sugar of milk may easily be obtained in a pure condition, and, indeed, as it appears in the market it is one of those commercial chemicals that most nearly approach purity.

If sugar of milk is crystallized by *cooling* its aqueous solution, and afterward dried, the crystals contain 5 per cent., or 1 molecule, of water: $C_{12}H_{22}O_{11}.H_2O$. On the other hand, if it crystallizes during *evaporation*, the crystals are anhydrous: $C_{12}H_{22}O_{11}$, a circumstance which

THE MICROTOME ARRANGED FOR FREEZING WITH ICE AND SALT.

(The glass plate screwed to the top of the instrument is not shown in the engraving.)

has formerly often been overlooked in calculating the results of milk analyses.

When long kept in dry, warm rooms, crystallized sugar of milk loses any moisture mechanically inclosed by the crystals. For this reason, old stock is always perferred to new. Unseasoned milk-sugar is apt to become sticky during powdering, and as it easily becomes warm during this operation, often turns into a caoutchouc-like mass. On the other hand, if the milk-sugar has been properly dried, no such disagreeable results will occur.

One of the first steps in the manufacture of milk-sugar is the removal of albuminoids and fat. The more complete the separation of the latter, the more easy will be the crystallization of the sugar. On this account we find the manufacture of milk-sugar almost exclusively combined with that of "Swiss" cheese, particularly in the Alps, where the uniform method of feeding, the low temperature of the air, and the fact that the milk is usually worked up for cheese at its place of production, combine in facilitating an almost complete separation of the various constituents of the milk.

Though comparatively insignificant alongside of the production of cheese and butter, yet the manufacture of milk-sugar has gradually grown up and become almost localized in the cantons of Berne and Luzerne. According to the statements of some manufacturers residing in the district, sugar of milk has been produced there, as a commercial article, during the past four hundred years.

The first customer was Italy, which even to-day consumes considerable quantities for medicinal purposes—for instance, in the preparation of a popular laxative made from sugar of milk and lemon-juice.

At the present day, England and the United States are the chief consumers of milk-sugar, it being largely used in those countries in homœopathic as well as in allopathic practice, and also reported as being frequently employed as an addition to milk for feeding babies.† Upon the continent of Europe, cane-sugar is usually employed, instead of milk-sugar, on account of its being cheaper than the latter, the advantages of which, in other respects, are of course well recognized.

For technical purposes, milk-sugar never acquired much importance. It has been employed in the preparation of lactic acid, in silvering, and to a slight extent for making caramel.

Its consumption is remarkably uniform, while its production and value are the very reverse, fluctuating quite considerably. When the price is high, there is always an excess of production; in consequence of this, a sudden decline takes place, which again induces the manufacturer to reduce his output as much as possible, or to stop production altogether until he can resume it with some hope of profit.

2. THE MANUFACTURE OF CRUDE MILK-SUGAR OR "SUGAR-SAND."

The manufacture of milk-sugar is carried on almost exclusively in two stages:

1. Preparation of "sugar-sand" (*Zuckersand*), and
2. Crystallization,

which are usually effected in different localities and by different persons.

The manufacture of "sugar-sand" is carried on in the same Alps of the Swiss Cantons of Berne, Freiburg, and Luzerne, which produce the best Swiss cheese. According to the locality, the whey to be worked at one time differs in quantity between 300 and 1,000 liters (about 80 to 260 gallons). Every morning the milk just collected, as well as that of the previous evening, is poured from the milk pails directly into the "cheese kettles." When the casein has been separated, the remaining whey is heated to boiling, whereby a cream-like skin is formed on top, which is made to increase in quantity by the rapid addition of acidified whey ("whey vinegar"). The skin ("Vorbruch") is skimmed off and worked for butter. The addition of acidified whey produces a partial separation of the albuminoids ("Zieger") from the whey, and the butter fat is at the same time more completely raised to the surface.

Next follows the separation proper ("breaking") of the whey by the addition of more of the acidified liquor, about 15 liters for every 500, and gradual heating to incipient boiling. If this process is properly performed, the albuminoids will now rise to the surface in large lumps, the whey* will lose its white color and appear as a limpid, greenish liquid ("Schotte") covered with the coagulated albuminoids. The latter is skimmed off and the liquid portion transferred into the "sugar kettle." The quantity of whey ("Schotte") amounts to about 70 per cent. of the original milk.

A "cheese kettle" is suspended from a crane so as to permit its being quickly removed from the fire at the proper moment. These copper kettles are always embedded more than one-half in the fire-place. For boiling down ("sand-boiling," *Sandkochen*), kettles with very flat bottoms are selected, and these are permanently set in the stone-work in such a way that the fire can touch only the bottom. This arrangement prevents the fire from coming in contact with any portion of the kettle above the contents, which would rapidly burn or blister the copper. Sometimes two such kettles are set up over one fire-hearth. Grates are not used under any of these kettles in the Alps.

The mason-work consists of stones held together by clay. As may naturally be supposed, only wood is used as fuel, in the form of roughly split logs or roots. Its consumption is so great that the boiling of the sugar can only be carried on profitably in those Alps where there is an abundance of forests. But in some places, even there, the industry is forbidden on account of its consuming wood required for domestic or other purposes.

Five hundred liters (132 gallons) of whey ("Schotte") require, for boiling down, 1 cubic meter (1·3 cubic yards) of logs. The boiling in the sugar kettle is continued day and night, without intermission; as soon as the contents of the kettle have been removed, it is immediately charged with a new quantity of whey ("Schotte").

The boiling reduces each charge to about one-fifteenth of its original bulk, and leaves a brown, viscid, sweetly saline mass, the condition of which is judged from the manner in which a sample drops from a dipper. When it has arrived at the proper degree of concentration, it is dipped out into a tub where the sugar will crystallize out after twenty-four to forty-eight hours, if the operation has been properly conducted. The salts remain in solution, but the "sand" (crystallized sugar) retains a sharp saline taste, which is removed by stirring it with a sufficient amount of very cold water, allowing to settle, and decanting the liquid. The "sand" will then have acquired a bright yellow, almost white color. It is now filled into a sack, from which the excess of water still retained by it gradually drains off. As soon as a sack is filled—which depends on the quantity of whey operated on, and may require from two to eight days—it is carried down into the valley and sent to the refiner, who goes by the usual appellation of sugar-manufacturer ("Zuckerfabrikant"). Sometimes the whole of one summer's turn-out of "sugar-sand" is sold or contracted for in advance.

The strongly saline residuary liquids constitute an excellent fertilizer, being rich in potash and phosphoric acid. They contain every inorganic constituent necessary for the growth of plants, and are therefore as perfect a nourishment for the latter as the milk itself is for man.

The quality of the whey ("Schotte"), which should above all be clear and sweet, the manner of setting the kettles, and the whole manipulation of the boiling, all have a share in the success or failure of the process. It happens not unfrequently that the Alpine operator is compelled to give up the work altogether.

When the boiling is badly managed, the sirup in the kettle throws up foam, its volume, in spite of the continued boiling, becomes greater, and it acquires a darker color. On cooling such a sirup, it yields a jelly-like mass, intermingled with but a small quantity of sugar crystallized in form of grains of about the size of small shot. When properly boiled, 100 liters (26¼ gallons) of whey ("Schotte") yield on an average 3 kilogrammes (6 lb. 9¾ oz.) of washed, drained, and marketable "sand." There is some difference between the amount of sugar obtainable from Alpine whey and that from

* From the *American Druggist*, September.

† During the year 1878, I put on the market a new preparation, under the name of *Lactin*, which contains, besides milk-sugar, suitable proportions of those salts in which cow's milk is deficient when compared with woman's milk. Hence this preparation, if mixed with cow's milk, furnishes a product as closely as possible imitating woman's milk. This preparation has found much favor in Switzerland; but its introduction in other countries has been retarded or interfered with by worthless imitations.

* The author of the paper employs the term "Molken" in the ordinary sense of the English *whey*, being the whitish opalescent liquid remaining after the separation of the casein. This liquid, after further treatment to separate the albuminoids and the remainder of the fat still present, finally yields a transparent, greenish liquid, which the author terms "Schotten" or "Schotte." This name is often used promiscuously as a synonym for whey. But in the special sense in which the author uses it, there is no English equivalent. We have translated it in doubtful cases by whey ("Schotte").—*Ed. Amer. Drug.*

low-land whey; the former averaging 3 to 4 per cent., the latter 2½ to 3 per cent. in summer, and 2 to 2½ per cent. in the winter; though, when badly managed, the boiling may yield only ½ per cent. or thereabout.

It frequently happens that the "sand" is sent off quite wet, so that it begins to drip again during the transport. In this case, it still contains from 15 to 20 per cent. of water. Since it readily becomes mouldy while wet, it is important that it should reach the refiner as soon as possible. In consequence of the dripping and the evaporation of moisture, the weight of the "sand," when delivered, is always less than when shipped; hence it is customary to settle in the contract where and by whom it is to be weighed. If it is sent by rail, the railway weigher's figures at the place of destination are usually taken as standard.

The price of "sugar-sand" varies, according to the quality and the rate of demand, between 70 and 160 francs per 100 kilos (220 lb.).

3. THE REFINERIES OF MILK-SUGAR.

There are five manufacturers, that is refiners, of milk-sugar in the Canton of Luzerne, all of them located in the same village, Marbach, where this industry seems to have sprung up originally, and where it has been transmitted as an heirloom in the same families. These manufacturers are at the same time peasants or tavern-keepers, carrying on the manufacture only during the summer, mostly with their own hands or their own people. When they are compelled to employ help, they usually engage a weak-minded or half-witted fellow, for the sake of preserving the secret of their process.

According to the demand and price of the sugar, the manufacturers buy or contract for the "sugar-sand," in the spring, from the alp keepers, in larger or smaller quantities, at higher or lower prices, for the ensuing summer. These bargains are concluded with a closeness and secrecy which is quite characteristic of these people: neither the seller nor the purchaser will ever divulge the contract price agreed upon. Neither is the purchase of the refined sugar from these people a simple or pleasant job. To a verbal question: "At what price do you sell?" the answer may be returned: "Likely, you know the price well enough, as you have been around to other manufacturers already." "How much have you to sell?" "Think I shall have enough to satisfy you," etc., etc. Moreover, it is quite a task to obtain a sight of a sample.

Besides these aristocrats among the manufacturers, there are other more recently established sugar manufacturers in Switzerland, who manufacture a purer quality of milk-sugar, in whiter and larger crystals, in order to be able to compete with the former.

The old manufacturers produce, together, about 50,000 to 60,000 kilos (110,000 to 130,000 lb.), the new ones perhaps an equal quantity; hence, the total yearly product in Switzerland amounts to 100,000 to 120,000 kilos (220,000 to 264,000 lb.), at a value of 200 to 300 francs per 100 kilos (40 to 60 dollars per 220 lb.); sometimes also ruling lower.

Outside of Switzerland, sugar of milk is produced only in scattered localities in Austria, Italy, France, and Germany; but the quantity produced in all these countries amounts to at most only one-third of that produced in Switzerland. A very white milk-sugar, "saccharum lactis germanicum," is made in Silesia (Germany), which is, however, said to be, for the most part, recrystallized Swiss sugar. This extra fine, white article, which used to bring about fifty per cent. more in price, is at present almost completely displaced by the first quality of Swiss sugar, which is at the same time cheaper. The Italian manufacture has not been able to survive, in spite of many experiments, and even under the protection of a considerable duty. In the Austrian Alpine province of Tyrol, and in the French province of Savoy, it is carried on but sparingly, not even the home demand being fully supplied. There is a factory in Savoy, working with a Picard's evaporating apparatus, in which the steam arising from the evaporation of the whey ("Schotte") is compressed, by means of a pump, in a copper worm situated in the kettle, where it becomes condensed and thereby gives out the requisite amount of heat for producing an equal weight of new steam from the whey ("Schotte"). Although this system is economical and of advantage in other lines of manufacture, it is unsuited for the preparation of milk-sugar. In the first place, it requires a large outlay for steam boiler, water power (or steam-engine), and evaporating apparatus. In the second place, a profit can be expected only if a very large quantity of whey—say 5,000 to 10,000 liters (1,300 to 2,600 gallons) per day—can be expected to be delivered. I say "expected" on purpose, because the delivery itself is connected with further difficulties. To obtain such a large quantity of whey, it must brought together from a large number of different cheese works, some of them at a distance of perhaps ten kilometers (6 miles), which increases the expense. And a single lot of whey from abnormal milk accidentally mixed with the rest may spoil the whole quantity.

According to my own extensive experience, the yield and quality of product depend also a good deal on the kind of vessels used for boiling, on the quantity of whey boiled at one time, and the time consumed in boiling, and I have found that none of the requisite conditions are fulfilled by using Piccard's apparatus. I am acquainted with the latter, through inspecting a factory in the canton of Freiburg, which failed three years ago. This factory was said to be an exact copy of that in Savoy, and only worked for a short time; as soon as capital ceased to find an attraction to it, it collapsed, with liabilities amounting to 80,000 francs.

A number of years ago I established works, at an expense of 5,000 francs, for boiling down a daily quantity of 2,000 to 3,000 liters (520 to 790 gallons) of whey ("Schotte") and refining the sugar, and I kept my works going summer and winter, employing sometimes even the whey ("Schotte") obtained from makers of Limburg cheese. Since my apparatus was built with a view of using steam, I erected them in connection with steam cheese works, saving thereby the special erection of a boiler. My yearly output amounted to 10,000 kilos (22,000 lb.), and found ready purchasers, particularly for the United States. Since my engagement in another branch of technical chemistry, my works and apparatus have remained unused.

4. THE REFINING OF MILK-SUGAR.

Immediately after arrival at the factory, the "sugar-sand" is rewashed, and then allowed to drain. The wash water dissolves a considerable quantity of the sugar, the latter being no longer embedded in or enveloped by the saline and sticky mother liquid, as during the first washing by the alp-keeper. Hence the manufacturer does not throw away the wash water, but recovers the dissolved milk-sugar by boiling down. The extent of washing depends upon the tint which the finished sugar is required to possess, a darker tint resulting from short washing, and a lighter tint from repeated washing. If the sand has a brown color, in which case it is usually crystallized in coarse granules, mere washing is insufficient, and a white product can be obtained only by recrystallization. This accounts for the preference which manufacturers show toward those alp keepers who turn out white and finely granulated "sugar-sand." When the sand has been properly washed and drained, it is dissolved in water, in a kettle set like that previously described, and more of it is gradually added, until the solution has acquired the density most favorable for crystallization. This is not recognizable by the eye as readily as the end of the operation in boiling down the whey ("Schotte"); nevertheless, the old manufacturers do not use any areometers. Usually a quantity of dark colored crystallized milk-sugar (recovered from the mother liquors) is dissolved at the same time with the other. During solution, a dirty foam rises to the surface, which is constantly removed until finally only a slightly tinted skin forms on top. In order to insure the more complete separation of impurities, it is customary to add some clarifying substances. As soon as the solution has attained the proper condition of purity and concentration, it is transferred, while still boiling hot, into copper lined or solid copper vessels which may be of any size and form.

Discarded cheese kettles, of a capacity of 200 to 1,000 liters (50 to 260 gallons), are often employed for this purpose; or old stills, or square wooden boxes lined with copper, etc. Smaller vessels, of a capacity of 300 liters (80 gallons) and less, are embedded in wood ashes, whereby the cooling is retarded, and its rate much more regular than when it is freely exposed. The crystals thus obtained from the smaller vessels will then turn out to be as well formed of those obtained from the larger. For the purpose of getting handsome crystalline groups, it is necessary to provide for a sufficient number of crystallizing "points," which is done by hanging into the liquid sticks of wood of the diameter of a goose-quill, which are stuck, in intervals of about 12 centimeters (4¾ inches), through holes in a frame laid across the top of the vessel. Concentrated solutions of course yield a larger quantity of crystals than more dilute ones. If an equal number of sticks be placed into two solutions differing only in density and contained in equal sized vessels, the thinner liquid will yield thinner plates of crystals at the sides and bottom, and "grapes"* of lesser diameter, than the thicker solution. But the product, in the former case, is lighter colored than in the latter. The size of the single crystals, or, in other words, the grain, depends on the rapidity of cooling and the clearness of the solution. After about ten days, the crystallization is completed; the mother liquid is then drawn off, which must be done rapidly, since the motion into which it is put by drawing off causes it to deposit a further quantity of milk-sugar in powder, which is apt to spoil the handsome appearance of the crystals. The sugar is now washed with fresh water, and then dried at a moderate temperature, which must be done thoroughly, otherwise the sugar will become mouldy. The crystalline plates taken from the bottom of the vessels require to be further purified, since they contain at their under surface any impurities which had settled at the bottom before the crystallization began. This impure layer is chopped off the pieces with a hatchet.

The mother liquid is again concentrated to the crystallizing point, and treated exactly as at first. The second crystallization yields a darker colored finely crystalline product, which is always redissolved along with a fresh lot of crude sugar. The mother liquid left after this second crystallization is boiled down to "sand;" but this is usually of so impure a character that it must be subjected to a preliminary purification before it can be utilized for obtaining marketable sugar.

All attempts to manufacture crystalline milk-sugar directly from whey ("Schotte"), on the principle of making loaf-sugar from beet-juice, have failed to lead to practical results. The difficulty is this, that not only the whole of the albumen and fat, but also the milk-salts and the lactic acid must be removed, and that the milk-salts which, by their presence, interfere greatly with the crystallization of the sugar, amount to one-half per cent. in the whey ("Schotte"), or to 10 per cent. of the weight of the sugar itself.†

Still more impracticable appears the proposition to precipitate the milk-sugar in the whey (Schotte") by alcohol. In the first place, at least *four* volumes of alcohol would be required for precipitating it in *one* volume of whey; and further, the precipitate would be contaminated by accompanying albuminoids, and would, therefore, have to be purified. Besides, a considerable amount of fuel would have to be consumed for the recovery of the alcohol, and more or less of the latter would be lost.

The manufacture of milk-sugar, like that of maple-sugar, with which it has many points in common, is not capable of being locally centralized beyond a certain limit. Besides other impediments already mentioned, an additional one is the limited consumption of the product. Until this has acquired much larger proportions, it is probable that the opinion of an old manufacturer, that "sugar-making is profitable only where the manufacturer is his own workman," will maintain its authority.

* This is the long, corncob-shaped mass of crystals attached to the sticks.

† One hundred parts of whey contain:

Milk-sugar	4·5 to 5·0
Lactic acid	0·2 to 0·5
Nitrogenized substances and fat	0·5 to 1·0
Salts	0·5 to 0·7
Water	94·2 to 92·8

The specific gravity of the whey is 1·026 to 1·028.

SAPONIFICATION BY NEUTRAL BODIES.

By A. COLSON.

ON examining the action of water, the author finds that the limit of saponification is reached more rapidly than with the fatty ethers. As regards the simple ethers derived from the xylenic glycols, the limit is the same for the three isomers, and probably for all the homologous ethers. The rapidity of saponification alone distinguishes the three isomers from each other. Alcohols attack the ethers of the aromatic series with rapidity at 100°, and very sensibly even at common temperatures. The alcohols ROH reacting upon the aromatic bromides give complex reactions, due, probably, to their dissymmetric constitution. They behave like true mixed bases, exchanging sometimes the group OH and sometimes the group RO.

RECENT SCIENTIFIC PROGRESS IN NERVOUS DISEASES.*

By L. A. MERRIAM, M.D., Omaha, Neb.; Professor of the Principles and Practice of Medicine in the University of Nebraska, College of Medicine, Lincoln, Neb.

NOT having read all the recent literature on nervous diseases published in various countries during the last few years, I cannot give all the new facts and principles discovered in neurological science, nor tell what may be their bearing upon the theoretical or practical problems of to-day. And if I had them all, I could not, in the short time allotted me to-day, present them in detail so as to make them of value to you. Even if I should sift out all the unproved theories, and present only what is accepted truth, it would take several half-hours to make clear what progress has been made. I shall, therefore, present only such topics as seem to me to be of most interest and value to the general practitioner, and such as I have gathered in my reading and study, leaving the subject of insanity to the pen of him who makes it his daily duty to care for these unfortunates. Progress has been made in this branch of medicine because of new facts learned in physics, chemistry, and physiology, and well supplemented by practical study of pathological processes, and careful clinical observations. With full and accurate data, a rational hypothesis may be formed of unseen processes, and, with the light we possess, correct methods of treatment adopted. That our data are often imperfect and our hypotheses unsound we are all well aware, hence our treatment is often wrong and the results disastrous. That this is true is not because of the imperfection of science alone. More often it is because we have not familiarized ourselves with the latest and best teachings upon the subject.

That mind exists wherever gray matter is found, whether in the axis-cylinder of Purkinje or the neuroplasm of the cell itself, and whether found in the tentacle of the cuttle fish, the tail of a dog, or the brain of a man, has been taught and proved by Herbert Spencer and accepted by the best men of the world, among whom we may mention Stricker, Bain, Gegenbauer, James Ross, Hughlings Jackson, and George Lewes. That the nervous system bears an intimate relationship to all normal and also to every morbid process, is an established fact in medical science. The epithelium, nails, teeth, hair, and beard are permeated by nervous influence, and respond readily to its action.

An instance of this kind is given by Anstie in his work on "Neuralgia," page 121 (*a*), where the hair becomes white during and immediately after an attack, returning to its normal color when free from neuralgia. Changes in the size and texture of the hair have also been noticed in neuralgia, many of the individual hairs becoming permanently hypertrophied. Even the terminal nerve fibers are not stable and unchangeable formations, but, on the contrary, new nerve fibers may form at any time of life from the living matter present in all tissues. Thus nerves may appear and disappear according to certain physiological necessities or certain physical conditions of the body. Motor and sensory nerves are not so radically different as many suppose. They not only both receive and conduct impressions, and in both directions, differing however only in degree, but they do something more, they have a certain power of simultaneously giving out molecular motion, so sharing the property of the vesicular matter.

It is a popular notion of the laity, held also by many physicians, that the anterior lobes of the cerebrum are especially the seat of intelligence; but this is erroneous, for it has been demonstrated that an injury or disease of the posterior lobes of the cerebrum does more damage to the intelligence than the same injury or disease when existing in the anterior lobes.

The hypothesis that there are particular nerves and particular centers possessing the particular power of inhibition has been much weakened by recent discoveries and experiments. "The chemical, physical, and biological sciences have overthrown the vitalistic doctrines of the past, and demonstrated a relationship between the forces which rule the inorganic world and the so-called vital force which is manifested in living forms." More than this the energy resulting from nerve action is but a modification of these same chemical and physical forces, and this correlation doubtless extends to the higher manifestations of nerve-energy—feeling and thought. The recognition of this correlation of the higher with the lower forces is a great step forward toward the solution of the intricate problems as to the cause, nature, and treatment of some nervous diseases.

The localization of cerebral lesions is receiving considerable attention of late, and bids fair to compare favorably with the localization of diseases of the chest. Ferrier, Hitzig, Schiff, Broca, Jackson, and others have done good work, the details of which would take too much of our time if now presented. There is a growing sentiment that many diseases not heretofore regarded as nervous (and, perhaps, all diseases) are of nervous origin. Herpes, vitiligo, ichthyosis, ecthyma, and pemphigus are now recognized as neurological in character, and very likely cholera, cancer, phthisis, diabetes, Bright's disease, Addison's disease, and some others will be ere long.

Neural physiology, neural pathology, and neural therapeutics are receiving marked attention of late, and neural pathology bids fair to take a prominent place in the pathology of the future.

Progress in physics, chemistry, physiology, psychology, and in short all biological sciences, opens the way to changes of views, not only in pathology, but also in therapeutics; and the position taken that most medicines given internally act through their influence on

* Read before the Nebraska State Medical Society, May 14, 1884.

the nervous structures is well sustained. Among neurological new diseases, I call your attention to a transitory tetanic rigidity of certain muscles first described in 1876 by Dr. Thomsen, of Schleswig, who had been subject to it all his life. The prominent symptom is a painless spasmodic rigidity of various and varying muscles coming on at the moment of executing a movement. For instance, a patient closes his hand, and is unable to open it; or, attempting to rise from a seat, finds himself poised in the act, and unable to proceed. The diagnosis of this disease is easy, but the cause and the pathology are not well understood.

Lathyrism is a new toxic paraplegia, epidemic among the natives of the mountains of Kabylie, in Africa, during the months of March and April. The cause is the ingestion of a leguminous plant (*Lathyrus cicera*) common to the country, and resorted to at certain times by the natives as food. The lateral columns of the cord seem to be mainly affected, and the symptoms are fever, pain in the back, formication and trembling, paralysis of motion and sensation, and vesical troubles, and, in a later stage, contractures, twitchings, and exaggerated reflexes. Cases are frequent, but few are fatal. It is hoped that this plant may be of value in the treatment of diseases of the spinal cord.

The new disease called *beriberi* or barbiers, or the Japanese *kak-ke*, is a disease of the peripheral nervous system, and is a subacute multiple neuritis. The characteristic symptoms of the disease are a motor and sensory paralysis of the legs, with muscular atrophy, enfeebled heart action, and, in the acute and pernicious form of the disease, dyspnœa and final asphyxiation.

Katatonia is a vaso-motor affection, characterized by a paralysis of the vascular coats and by a consequent hyperæmia of the cerebral tissues. Allochiria is a peculiar disease characterized by a perversion of sensibility and the erroneous reference of sensory impressions to the corresponding part of the other side of the body, as tickling the sole of one foot caused retraction of the other foot, etc.

Other comparatively new diseases are polio-myelitis anterior acuta, athetosis, pseudo-hypertrophic spinal paralysis, and myxœdema. Hystero-epilepsy has attracted some recent attention; but it is a misnomer, for there is no epilepsy present. It is pure hysteria of a severe type, and should be termed hysteria-major; the more common form being properly termed hysteria-minor.

Fifty years ago, Dr. J. R. Mitchell, of Philadelphia, held that acute, sub-acute, and chronic rheumatism were diseases of the spinal cord, and evidence is accumulating to support the position; while progressive arthritis deformans has been placed among diseases of the nervous system. Certain maculæ, papulæ, or ecchymoses have been observed in some cases of locomotor ataxia, and it is thought that they are intimately connected with morbid alterations of the posterior columns of the spinal cord. In an epidemic of ergotism, Tuczek found that tabes dorsalis was artificially produced by this drug in many of his patients. Passive exercise and rest as the principal remedies, even when the cause is not syphilis, are held to cure some and to relieve many of these cases of posterior spinal sclerosis.

The effect of syphilis upon the nervous system has been thoroughly studied during the last few years, and many important additions made to our knowledge of the pathology and symptomatology, which, were I to discuss to-day, would extend this paper far beyond the time allotted me. The treatment of diseases of the nervous system has improved because of increasing confidence in the remedial powers of nature, and because physicians discriminate better in the choice of the agents they use, giving less in quantity and paying more attention to the environment of the patient.

The surgical treatment of epilepsy by ligature of one or both of the vertebral arteries has been done in the Liverpool Workhouse Hospital many times during the last three years.

The results have been very satisfactory in the first twenty-one cases operated upon by Wm. Alexander, M.D. Twelve are said to have been cured, eight were very much improved, and one died in a fit two months after, having left the hospital very much better than when he entered. Several other cases have been reported by other surgeons, and the outlook is favorable for the surgical treatment of epilepsy.

Static electricity has come into use in several forms of paralysis, and has been successful where other forms of electricity have failed.

The therapeutic action of magnets, or magneto-therapy, has been introduced by Dr. John Vansant and later by Dr. Bartholow. They found that when the south pole was applied to a blister it caused a momentary sharp sensation, but when the north pole was applied to the blister there was no sensation at time of contact; but after removal of the magnet the original pain remarkably decreased. Numerous experiments upon other parts of the body, upon animals, and vegetables, prove the influence of the magnet to be of value in the treatment of nervous diseases.

Much more has been done in the way of scientific progress in the management of nervous diseases, but its presentation at this time would make this report too long. In conclusion, let me call your attention to one of the greatest works on the diseases of the nervous system that has lately been issued from the press, and it is from the brain and pen of James Ross, of London.

In this work he passes in review the fundamental laws of nervous structure and function, and he shows that the whole of the intricate processes illustrates the one great law of evolution. It is supposed by many persons that evolution has to do only with the development of animal life, with what is commonly called Darwinism. But those of you who are familiar with Herbert Spencer's system of philosophy know better. Ross recognizes Spencer's work as of great value, and as bringing into fundamental harmony many superficially different phenomena of nervous diseases.—*Alienist and Neurologist.*

THE London papers are strongly opposing the further use of aniline dyes, particularly in the coloring of hose, the same having been found dangerous to life in consequence of the large quantities of arsenic used in the manufacture. An effort is making to revive interest in madder and indego dyes, which it is hoped will prove successful.

THE MEMBRANA TYMPANI.

By O. A. PALMER, M.D.

THE tympanic membrane (see Fig. 1) is at the inner extremity of the auditory canal, and is inclined forward, downward, and inward in adults, but in children it is more slanting, so that during infantile life it is difficult to see it. It is oval in form, its vertical diameter being about five lines, and its transverse four lines. It is depressed inward, causing its external surface to present a concavity, at the apex of which is seen the handle of the malleus. It is composed of an external dermic layer that has no glands or hairs, a middle fibrous and internal mucous layer.

The fibrous has an external and internal layer. Between these two layers is the long handle of the malleus and the short process. The long process moves in a groove, like an enarthrodial joint. If we look upon a normal drum (see Fig. 2) in an adult, we can see a few points of special interest. After viewing the drum in general, we should notice particularly the long and short processes of the malleus, and the cone of light, which is first to change its appearance when the drum becomes diseased. This triangle of light is caused by the funnel shape of the membrane and the reflecting qualities of the dermic layer. The color of a normal membrane varies in different persons. It is generally bluish or light gray. The age of the person and the anatomical variations around and in it make a difference in the color. It is lighter in infants, and usually shaded with pink.

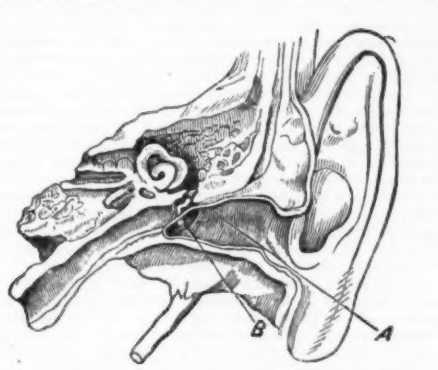


FIG. 1.—A, Auditory Canal. B, Membrana Tympani.

The membrana tympani is set into rapid vibrations when the waves of sound are conducted against it. The drum-head holds the long process of the malleus in position, and supports through it the entire chain of bones.

The bones transmit the vibrations received from the tympanic membrane to the membrane in the foramen ovale of the vestibule. The tympanum is protected from cold air and from foreign substances by the drum. Some observers claim that there may be a congenital absence of this membrane. I have never seen a case of this kind, and I think it must be rare.

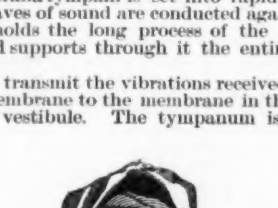


FIG. 2.—A, Drum-membrane. B, Long Handle of the Malleus. C, Short Process of the Malleus. D, Triangle of Light.

It is very doubtful whether there are ever two drumheads formed, as stated by some writers. The second one is a new growth, which may take place in some abnormal conditions of the meatus. I have seen quite a number of anomalies in size, form, and inclination of the drum, but they are of no great importance. The drum may be triangular. Its size depends on the width of the canal. The angle which the normal inclination of the drum forms with the upper wall of the auditory canal is 140°. It is stated by some investigators that musical people have a very perpendicular position of the drum membrane, and that a nearly horizontal position of the membrane is seen in adults with congenital deafmutism.

The drum is liable to injuries in many ways. It is easily injured by things thrust into the external canal. Many persons use hairpins, earspoons, sticks, and needles to remove earwax and to relieve itching. This practice should be discouraged, as the membrane is often torn by their use.

An unskillful physician, or the attempts of the laity, may rupture the drum in trying to remove a foreign body from the canal. Blows by the hand or by a snowball have ruptured the drum. No parent or teacher should box a child on the ear, because the column of air over it suffers a sudden condensation that may be very harmful to the drum in many ways.

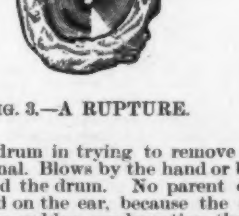


FIG. 3.—A RUPTURE.

A rupture (see Fig. 3) appears as a red line on the drum. Its edges separate from each other when the patient blows his nose or forces air through the Eustachian tube into the middle ear by Valsalvan's inflation. At the time of the inflation, a blowing or whistling sound may be produced in the ear. At the time the membrane bursts, the patient feels a sudden pain, deep in the ear, which gradually subsides. Still it may last for several hours. There is roaring and ringing in the ear, with impaired hearing. Usually some hæmorrhage takes place into the external canal. There may be extravasation of blood into the tympanic membrane. A rupture generally heals rapidly, without leaving any permanent trouble. Sometimes there is a moderate effusion of blood into the tympanum, but it does not interfere with the healing process. It is necessary that the edges of the wound are not irritated or separated in order to have a rapid union. It is improper to syringe or otherwise interfere with the ear, as it prevents healing. If the edges of the rupture are irritated, suppuration will destroy a portion of the drum that may require a long time to heal in some cases. Suppuration may follow a perforation caused by a box on the ear.

A perforation (see Fig. 4) may occur in any part of the membrane. It is the most common in the anterior or posterior lower quadrant. It is the most rare at the long handle of the malleus and at the periphery, because at these points the lamina propria is quite strong, and offers a greater resistance to destructive processes than any other portion. The size of the perforations vary. They may be small as a fine needle, or nearly as large as the auditory canal, as when most of the drum is lost. The common shape of a perforation is oval or round. Its most common cause is purulent inflammation of the middle ear. In these cases the perforation takes place from within outward. It may occur from without inward. If the edges of a fresh perforation are carefully observed, they will be found quite irregular and rough, while the edges of an old one are smooth, thickened or thinned, and sometimes calcified. Now and then I see a case where the edges of the perforation are partially or completely united with the mucous membranes of the labyrinthine wall. Double or triple perforations may take place. I believe it is generally admitted that the membrana tympani may be perforated at different points in tuberculosis, scarlatina, and pyæmia. Recent perforations heal without leaving any abnormal changes. When a large and old one heals, a persistent cicatrix results. If a cicatrix is attached to the labyrinth, it will occasionally secrete pus and require treatment.—*Amer. Med. Jour.*

FIG. 4.—A PERFORATION.

NEW SYSTEM OF CLEANING SEWERS.

IN 1882 several quarters of Rome were literally infected with odors that were given off by the sewers. As these latter had a slope of but 1¾ inches in 40, the washing waters did not have the necessary force to carry along the matter suspended in the liquid part of the sewage. The consequence was that this matter decomposed and produced deleterious gases. It became necessary, therefore, to think of devising a system that should secure the cleaning of the sewers and properly ventilate them. Since, on another hand, the problem could not be solved by a continuous introduction of water, seeing that it would have required a large volume of the latter for such a purpose, washing wells or chambers were constructed, and so arranged as to send a stated quantity of water automatically and at equal intervals of time, in other words, so as to discharge a flood into the sewer.

Figs. 1 and 2 give vertical sections of one of these

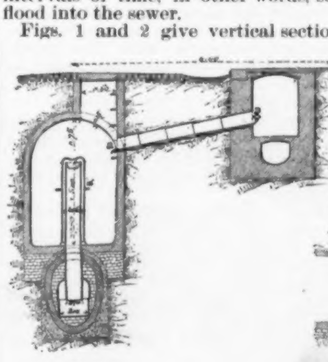


FIG. 1.
Longitudinal Section.

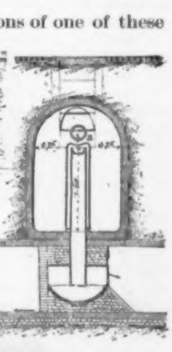


FIG. 2.
Transverse Section.

wells constructed over the sewer and having a capacity of 550 cubic feet. The bottom of the well is traversed by a vertical cast iron pipe, open at both extremities, one of the latter debouching into the sewer and the other into the well. The portion situated in the well is covered with a second pipe, which is closed at its upper part and is provided with orifices at its lower.

The washing water is led into the well by a leaden conduit provided with a cock, *a*, which regulates the flow of the liquid. This conduit is itself inclosed in an earthen-ware pipe through which passes the air necessary for the siphon's operation.

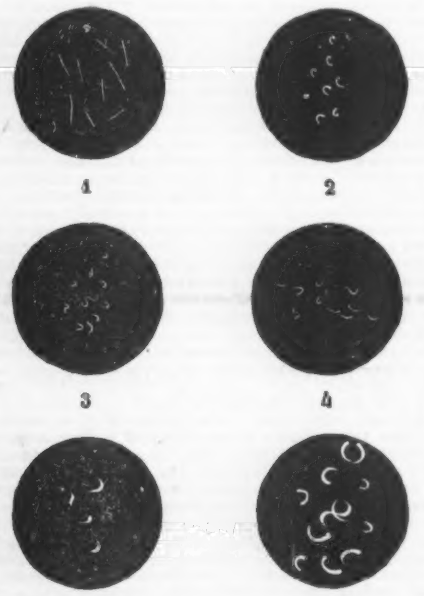
It will be seen that as soon as the water has reached the level of the upper orifice of the vertical pipe, the siphon will begin to work, and there will flow into the sewer a volume of water equal to 550 gallons in the space of 26 seconds. In order to attain such a result, it is important to give the orifice in the internal pipe a proper form. At first, the cast iron pipe was simply cut perpendicularly to its length. The orifice was therefore cylindrical, and the siphon worked badly, the

quantity of water that flowed along the pipe being just equal to that which was led by the leaden conduit. The top of the internal pipes was therefore provided with a cylindrical mouthpiece of brass, which had an accurately horizontal edge, and which forced the water to flow uniformly over the entire circumference of the orifice. But a satisfactory result was reached by substituting a mouthpiece of conical form for the other. Under these circumstances a rapid flow is obtained, a strong suction being produced, and the water making its exit from the pipe in the same manner as from the orifice of a pump pipe.

Each well is fitted twice a day, thus giving a consumption of 1,100 cubic feet of washing water. Wells are established at the terminus of each collector, and, besides this, others are distributed upon the line of certain sewers in such a way that one siphon has to wash 715 feet of sewer.—*Les Annales des Travaux Publics, from Centralblatt der Bauverwaltung.*

THE CHOLERA MICROBE.

IN the waters of the Seine, taken at the level of the Chatelet, curved bacilli of the cholera-generating type are found in swarms. They are ten times more numerous there than in the sewage waters of the same quarter, and in which the common microbes of putrefaction predominate. These bacilli, moreover, are associated with other curved bacilli which do not correspond to Mr. Koch's description, and which doubtless represent different species. More than two months ago I found the same elements present in the waters of a canal that serves as a sewer for a part of the city of Lille, and I have also found them in two cases of cholera (Asiatic in my opinion) observed by myself at Lille in September. Since that epoch we have had here a little cholera of attenuated character, as at Paris before the present period. In the Lille waters the cholera-generating type is the rarest among the curved forms, while in the Seine water it is at the present moment the most common. Preparations that have been sent to me from Marseilles by Messrs. Nicati and Rietsch have permitted me to establish the identity of this bacillus,



CHOLERA MICROBES.

1. Bacillus of tuberculosis taken as a standard of comparison. 2, 3, 4. Different types of bacilli from Koch's preparations compared with the bacilli found in the Seine. 5, 6. Other microbes found in the Seine.

in form, with that of Mr. Koch. Is it the same? In his last memoir Mr. Koch appears to no longer attribute much importance to the form, merely, of this microbe, and declares that he can only recognize it by the way it behaves under culture. . . .

It seems to me that a search for curved microbes, whose presence in water was unknown till recently, is interesting; and our friend Daremberg, who has already caused a salutary agitation on the subject of the impurity of the Seine waters, might perhaps derive some benefit from it. The annexed engraving shows some of the different forms of curved bacilli that I have met with.—*Dr. Hericourt, in Revue Scientifique.*

DRUMLINS.

DRUMLINS are hills composed of compact, unstratified glacial drift or till; their form is usually elongate or oval, with a ratio of horizontal axes varying from 6 : 1 to 1 : 1; the longer axis is parallel to former local glacial motion, as shown by neighboring striation or transportation of bowlders; the profile is generally smoothly arched and commonly almost symmetrical: terminal slopes, 3° to 10°; lateral slopes, 10° to 20°; length, one-eighth to two or more miles; height, 20 to 250 feet above base. The general uniformity of outline in any single region is very noticeable; indeed, the view from the summit of a commanding drumlin, in the center of a group, shows as characteristic a landscape as that seen in looking from the Puy de Dôme over the extinct volcanoes of Auvergne. Moreover, the control that drumlins exercise over the laying out of roads and the division of property is so complete in districts where they abound that it is the rule to find roads, fields, gardens, and even houses oriented in obedience to the march of the old ice invasion. About Boston, there are hundreds of dwellings whose walls thus stand in close parallelism with the glacial scratches on the bed rock beneath them. In a recent number of *Science*, I have given several sketches of these drift-hills.

Distribution.—The absence of drumlins in non-glaciated regions confirms the evidence that gives them a directly glacial origin. When found, they occur either scattered about without apparent system, or crowded together in groups. The most extensive group of which I have a map is in northwestern Ireland, the district described by Kinahan and Close in their paper on the General Glaciation of Iar-Connaught, Dublin, 1872. The direction of neighboring glacial striæ is shown by arrows, which, although not all parallel to one another, are strikingly parallel to the nearest drift ridges. These long drumlins "consist of stiff unstratified bowlder clay, containing well blunted and scratched stones and blocks; they have been most unquestionably formed by the rock-scoring streams [of ice], since they are, with very rare accidental exceptions, always parallel to the striæ near them" (op. cit., p. 6). They occur plentifully elsewhere in Ireland (Close), and in Scotland (A. and J. Geikie), and are well shown on some of the shaded one-inch maps of the Ordnance Survey; but I have not been able to identify them satisfactorily in descriptions of the drift of Scandinavia, Germany, or Switzerland. Erdmann's "Exposé des formations quaternaires de la Suede" (Stockholm, 1868) may perhaps refer to drumlins on p. 24 . . . "dans les plaines, ces masses de gravier (bowlder clay) s'élèvent en nombre considérable des couches d'argile environnantes, sous forme de collines plus ou moin grandes." Desor did not include them as characteristic features of his "Paysage morainique" (Paris, 1875). If occurring on the continent, they have not received the attention they deserve.

On this side of the Atlantic, they are common in many States. A fine group has been found in southeastern New Hampshire and the adjoining part of Massachusetts, which is represented on the geological atlas of the former State (1878). The group about Boston has been well described by Mr. Warren Upham (Proc. Bost. Soc. Nat. Hist., 1879, xx., 223). Corey's hill, the most northern of the group in the town of Brookline, is one of the best examples, and is well seen from the city looking westward up the Back Bay. A fine series of drumlins stretches from about Spencer, Mass., to Pomfret, Conn., but the detailed study that it would well repay has not yet been attempted. Members of this series occur near Charlton Station, Boston and Albany Railroad, with their bases at an elevation of 900 feet above sea-level, and others stand still higher. The portion of the group in Connecticut is described by Percival as follows: "The district extending north from Hampton, through Abington, Pomfret, and Woodstock, is characterized by a series of very smoothly rounded, detached hills, in which the rock is usually entirely concealed. These form a striking contrast with the longer and more continuous [rocky] ridges of the adjoining formations" (Geol. Conn., 1842, 256; also 461, 479, 485). Prof. G. H. Stone reports that drumlins of large size, like those about Boston, have not been found in Maine. Western New York, between Syracuse and Rochester presents a surprising number of parallel north-and-south drift hills, probably familiar to many travelers by rail. Some of them are so long, smooth, and even that the country thereabouts has been described as *fluted*. These were long ago described by Prof. Jas. Hall in his Geology of the 4th district of New York (1843); since then they have been strangely neglected until examined by Dr. L. Johnson, who has lately published a paper entitled "The parallel drift-hills of Western New York" (Trans. N. Y. Acad. Sci., 1882, i., 77). Some of the ridges are "two or three miles long, and attain elevations of 100 or 200 feet above the intervening valleys; but the greater number are shorter and steeper. Many of them were, when first cleared of timber, very steep at their north ends, and on their east and west sides; but, with very rare exception, the southern slope is gradual." These and other irregularities of form may require that some of the hills of this region should be separated from drumlins as here defined. In Wisconsin, the drift-hills, as described by Prof. T. C. Chamberlain, "are arranged in lines, and their longer axes invariably lie parallel to the movement of the ice. In some localities, especially in Dodge and Jefferson counties, these are mainly replaced by long parallel ridges, sometimes several miles in length, with corresponding linear marshes interspersed. These correspond accurately to the direction of ice motion." (Geol. Wisconsin, 1883, i., 283.) According to Mr. Upham, drumlins are not found in the abundant drift of Minnesota. A few examples are mentioned for Pennsylvania near its western border by Prof. Lewis. (2d Geol. Surv. Pa., Terminal Moraine, 1884, 29, 188.) It is evident enough from this review that the distribution of drumlins is insufficiently known.

The first clear reference to drumlins as directly dependent on glacial action for their form was made by M. H. Close (on the glaciation of the rocks near Dublin, Journ. Roy. Geol. Soc. Ireland, 1864, i., 3); they are here said to be parallel to the neighboring striæ, and hence like these dependent on the ice-sheet for their present attitude and form. The same conclusion is presented in the paper of 1866, above mentioned, when the name *drumlin* was first specially proposed for them. Still later, when describing the physical geography of the neighborhood of Dublin (id., v., 1877, 49), Close writes: "It is perfectly certain that it must have been the rock-scoring agent which produced the bowlder-clay ridges." Besides this, Kinahan and Close, in the pamphlet above named, stated their opinion that drumlins were formed in a way "similar to that by which a stream of water often makes longitudinal ridges of sand in its bed." This is to my mind the best suggestion yet given to account for them.

They seem to be masses of unstratified drift slowly and locally accumulated under the irregularly moving ice-sheet, where more material was brought than could be carried away. The evidence for the sub-glacial growth of drumlins may be summarized as follows: The scratched stones in the mass of bowlder-clay show a differential motion of its several parts as they were scraped and rubbed along from a generally northern source, and gradually accumulated where now found.* The compactness of the mass suggests an origin under heavy pressure. The attitude of the hills demonstrates a close dependence on the motion of the ice-sheet. The superposition of kames on their flanks proves that their present form was essentially completed when they were uncovered by the ice-sheet; and the small change of form in the kames shows that the drumlins also can have suffered very little from post-glacial erosion;* the faint channeling of their smooth slopes by rain measures the small amount of denudation that they have suffered since they were made. It must therefore be concluded that they were finished closely as we now see them when the ice melted away, and hence that they were of sub-glacial construction.

The supposed manner of accumulation of drumlins may be briefly sketched. It is well known that a stream of running water will at one point carry along silt and sand that must be dropped a little farther on where the current slackens; and the bank thus begun grows slowly in a form of least resistance, attaining a maximum size when its increase of volume has so far diminished the cross-section of the stream, and consequently increased the velocity, that no more detritus can be dropped there; but even then, one end may be worn away while the other grows; the adjustment of velocity to channel is not permanent. The motion of a glacial sheet has been justly compared to that of a broad river. The comparison may be extended so as to liken the active head waters of a stream to the presumably fast-moving part of the ice-sheet near its source or center of dispersion, where the greatest erosion generally takes place. The delta of a river corresponds to the thinner and slower-moving marginal area of an ice-sheet, where drift brought from elsewhere is quietly and evenly deposited as in Minnesota, and where erosion is relatively weak.† A still further agreement is discovered in comparing the drumlins and sand banks found in the middle course of the molten and solid streams, as suggested by the several authors quoted above. In view of the irregularity of the surface on which the ice-sheet moved, and of the greater weakness of some rocks than others, we must suppose an irregular velocity in the motion of the ice and an unequal distribution of the rubbish beneath it. If the faster motion at one place cause an excess of erosion there, the slower motion at another place may bring about an excess of deposition. This difference of action is known to prevail between the central and marginal parts of glaciated areas; and the local accumulation of drumlins in an intermediate region gives a smaller example of these two parts played by the ice. If the causes of the irregular motion of the ice lie in the general form of the country, the location of faster and slower currents will be relatively permanent; the districts of faster currents would be found where the greatest volume of ice is allowed to pass, and some of the points of retardation may be the seats of long continued drumlin growth. The drumlins thus begun will depend less on the immediately local form of the ground than on the topography of a more considerable district, and hence we need not suppose every drumlin to have begun its growth upon a knob of rock, although the beginning of many hills may have been thus determined. Once begun, the drumlins will go on increasing in size as long as deposition exceeds erosion, always maintaining an arched form of least resistance, until a maximum size is reached, or until the ice melts away; and in their growth they will approach the form to which rough, rocky hills would be reduced by the reverse process of erosion, if time enough were allowed. Under unending glaciation, the whole surface must be rubbed down smooth.

I am well aware that it is venturesome to go so far as this in theory before all the facts are in. When more is known of the distribution of drumlins, the suggestions here given may have to be abandoned; but it is nevertheless impossible to resist theorizing, and perhaps the collection of facts, *pro* and *contra*, may be hastened by a little venture in speculation. It is very desirable that the regions occupied by drumlins should be more closely studied; when this is done, it may be possible to give in more definite terms the reasons for their choice of attitude, and additional chapters in their history may then be written.—*Abstract from a paper in the Amer. Jour. of Science, by W. M. Davis.*

* A paper by Mr. Hugh Miller, read at the recent Montreal meeting of the British Association, gave several admirable illustrations of this "flux-ion structure in till."

* This assumes a point on which there is now a tolerably general agreement, namely, that kames were formed close by the front of the melting and retreating ice.

† The recent history of this comparison is given in my paper on Glacial Erosion, Proc. Bost. Soc. Nat. Hist., 1882, xxii., 33.

MARBLE CAVE.

ROARK MOUNTAIN, in Stone County, Missouri, is the highest point of the Ozark range within a radius of twenty-five miles. It is surrounded by the headwaters of Roark Creek, Big and Little Indian Creeks, Fall Creek, and Jacob's Branch, all flowing in different directions. To the south is White River, toward which the mountain slopes; to the north, James River. The first is about three, the other six miles from the top of the mountain.

That top is a strip of tableland, about one mile long and from an eighth to a quarter of a mile in width; one thousand feet above the level of White River. A magnificent view presents itself from that point. The eye sweeps over range after range of mountains, heavily timbered with oak, black-walnut, cedar, and pine; valleys with streams meandering through them; a bracing, invigorating atmosphere; abundance of game, springs of pure water; and medicinal springs, chalybeate, sulphur, etc. Almost every variety of ordinary fruit finds the soil and climate congenial.

Nearly in the middle of the level space on the top of Roark Mountain is a depression, an oval-shaped sink, two hundred and fifty feet long and eighty feet at its greatest width. This sink is the mouth of a funnel, standing perpendicular above the mouth of a gigantic cave, called Marble Cave, after the rock by which it is walled in. The mouth of the cave is in the middle of its roof.

The sides of the funnel taper downward, rather steeply, till a depth of one hundred feet is reached. Not so steeply however but that one can climb down them along a rugged path. These sides are of huge blocks of flint rock with earth between, sufficient to afford, at intervals, footing for trees one foot and a half in diameter.

After having gone down the side of the funnel shaped sink, one comes to another opening nearly oval, thirty feet long and from five to fifteen feet in width, the bottom of the funnel. This opening is at two places bridged over by large rocks, which have fallen down and become wedged in. It really is a hole in the top of the roof of the cave, which roof here is from fifteen to twenty-five feet thick. Now the rock is gray marble. Below one of the wedged-in rocks, a ledge projects, jutting out from the side of the hole in the roof of the

cave. A path leads to that ledge. From the ledge one descends by means of a ladder, sixty-five feet long, to the top of a pile of rock, earth, and rubbish, rising upward in the shape of an irregular truncated cone, from about the middle of the floor of the cave. That pile is about two-hundred feet high. A rough winding path along its side leads to the floor of the cave.

The cave is nearly circular, in the shape of an inverted bowl, flattened at the top. That flat top is of dove-colored marble and two hundred feet in diameter. The floor of the cave is seven hundred feet in diameter. The roof is about two hundred and fifty feet high. The sides are along the bottom of granite. Above that comes a layer of onyx, mostly white and sixty feet thick; above that thick layers of dove-colored, variegated, brown, red, and drab marble, mostly dove-colored; and between the layers of marble are thin layers of flint rock. Between the layers of marble in the sides and the flat marble top of the roof is limestone.

The basis of the cone-shaped pile in the cave is from 200 feet to 400 feet in diameter. It comes at one place within a short distance from the wall of the cave, and at another leaves a space of nearly 500 feet. It seems to have been caused by a volcanic upheaval, and increased by earth and debris falling down through the opening above. At noon the vertical rays of the sun strike the top, rendering the strata in the roof dimly visible, and more clearly outlining the upper part of the cone-shaped pile. For the rest, the cave is dark.

Countless bats have since centuries been swarming in the cave and through the passages and rooms connected therewith, whenever the weather is cool. The floor of the cave is covered by a layer of guano, the deposit of those bats, and by myriads of carcasses of such as died and decayed long since; which last is evidenced by numerous small bones found mixed in. That layer of guano has been probed to a depth of 25 feet, and no bottom reached. Guano is also found in stretches on the sides of the cuneiform pile to a height of 50 feet; and further up, mixed with stone and dirt, clear to the top.

Where the foot of the cone is farthest from the wall of the cave, is a huge stalagmite, about 50 feet high, transparent, white and hollow. At its base is an open arch, through which one can climb and ascend on the inside to a height of about 25 feet, when one is stopped by a spring of very clear water. This water streams down to a basin hollowed in the bottom of the stalagmite.

Between the stalagmite and the side of the cone is a gigantic block of white onyx, about oblong at the base and nearly circular at the top. It tapers upward to a height of fifty feet. The width of front and back at the base is 40 feet, the thickness 30 feet. At the top, where the shape is circular or almost so, it is 8 feet across. Projecting rocks can be used as an irregular stairway for ascending to the top. About half way up is an opening. The block is hollow and divided in cells, through which one can wind one's way.

A light carried inside is dimly perceptible outside, through considerable thickness, the onyx being sufficiently translucent for an outsider to follow with the eye the course of the person inside carrying the light. The outside is decorated by water formations in the shape of columns and draperies; and on the stone appear like rude carvings in relief of human faces. This block has been named the

GREAT WHITE THRONE.

From the arched wall of the cave, behind the Great White Throne, hang down over 1,000 stalactites, varying in length from a few inches to 20 feet, and in color crystalline, white, yellow, and red, here and there interlacing and forming what looks like delicate network.

From the top of the roof, where it begins to be vaulted, yellowish stalactites of various sizes hang down in groups. Touched for a moment by a ray of the noon sun, the tips glisten beautifully.

Fifteen passages lead from the cave in various directions farther into the mountain. Their walls, like those of the cave, are of marble, flint, onyx, and granite, in layers. Everywhere

BATS AND GUANO.

To any one making the round of the cave, starting from where the wall presents the widest space without any opening, and moving with the wall on the right hand, they present themselves in the following order:

1. The largest, 30 feet wide and 15 feet high, divided in two unequal parts by a pillar, is called the

EMERY AVENUE,

after Capt. J. B. Emery, Postmaster at Lamar, Mo., the president of the company which owns the cave. This passage is only about 10 feet long, and leads into a room 250 feet long, 30 feet wide, and from 10 to 20 feet high, the floor slanting and saddle-shaped near the middle. This room is called the

MOTHER HUBBARD ROOM,

by reason of a rock in the shape of an old woman with cape and hood, bending from a stool over a grate, near what seems to be a cupboard in the wall. This room ends in a mass of rock piled up irregularly. Same kind of rock as in the cave, and floor thickly covered with guano. In this pile of rock is a narrow passage through which one has to creep. It is 30 feet long, and ends in a room about 20 feet wide, 30 feet long, and 40 feet high. This room, during cool weather, is so full with bats that they completely cover and hide the wall all around, giving it the appearance of black velvet. Whenever disturbed they fly about in such numbers as to put out any light not protected by a lantern, and incessantly flap against one's face. Hence the room is called

THE BATTERY.

A very thick layer of guano covers the floor. At the further end is a small stream of water, about 3 inches deep and three feet wide, all saturated with guano, and running onward between rocks. A boy, Dick Powell, son of a member of the cave company, followed the stream for a distance of 100 feet, and then, coming to a precipice, turned back. Through the passage from the Battery to the Mother Hubbard room, a strong inward current of air constantly forces itself. Therefore this passage has been designated as the

INWARD WIND PASSAGE.

2. A second passage, about 3½ feet high and the same in width, is called

THE OUTWARD WIND PASSAGE,

by reason of a current of air rushing from the cave with such force as to extinguish any light not in a lantern. It has been explored only about 150 feet, at which point progress is stopped by cross strata of onyx, dividing the passage and rendering it too narrow. A large fire of pine knots once was kindled in it, and the draught carried the smoke off without hinderance. Probably it leads to an opening in the side of the mountain.

3. A third passage, slanting with an incline of 45 degrees, and circular like a hole, 3½ feet in diameter, leads to a room about 30 feet long, 10 feet wide, and 15 feet high. This room is called

POWELL'S ROOM,

after T. S. Powell, vice-president of the company, who discovered it. A short, straight passage, also a creepway, leads from this to a similar room, in size half of the former. Another creepway connects this second room with a third still smaller, in size about one third of the first. The floors of these three rooms are vast deposits of guano, depth unknown. A fourth passage leads farther on, but has not been explored, because it has been greatly stopped up with guano. The walls of these three rooms are smooth blocks of white onyx and dove-colored and red marble piled up.

4. A fourth passage, in size similar to the former, runs down at an angle of 45 degrees, to an almost circular room about 15 feet in diameter and 10 feet high. This room seems to have been a den of bears, as the ground, also a guano bottom, is strewn with bones of bears. Waste water, from the spring in the cave, runs through this room and into a farther room, visible, but not accessible along the stream. The guano is partly spoilt by the water. Rock, marble and onyx.

5. A fifth passage, the most tortuous of all, circular in shape, about 190 feet long, and at some points only 2½ feet high, leads to a room of serpentine shape, not over 3½ feet in height. The floor of this room is brilliant red clay, very strongly impregnated with saltpeter. Here neither bat nor guano is found. But the room, the length and width of which have not been accurately ascertained, is full with mummified animals. There are bears, panthers, otters, raccoons, opossums, wolves, foxes, lynxes, etc., and one specimen of what seems to be an antediluvian animal of the genus Pterodactylus. Also smaller animals, seemingly some kind of monkey. These mummies are in an attitude of repose, as if the animals had come here to die. Hence the room is called the

CEMETERY.

Hair on the dried-up skins is well preserved. The roof of the room is marble. The sides, so far as seen, are a glistening quartz, believed to be silica of zinc, but not yet analyzed. What may be beyond this room has not been ascertained.

6. A sixth passage is located at the rear of the spring. It is about 2 feet wide and 40 feet in height, and tapers toward the top. It really is a crack, about 30 feet long, in the rock, level and straight. Red, white, and brown stalactites hang down from the roof. They reach so low that one has to creep under them. It ends in a circular room, about 20 feet in diameter. The roof about 50 feet high, is conical. Water constantly falls from points all over the ceiling, as if that were a colander or a sieve. This creates a perfect shower. The water escapes through interstices between blocks and fragments of rock which constitute the floor. The sides of the room are enveloped in water formations, and the sides of the roof are covered with bright brown stalactites. An immense stalactite hangs from the center. The room is called the

SHOWER-BATH ROOM.

The space below has not been examined. Neither has it been ascertained where the water goes to.

7. A seventh passage has a round opening 3 feet in diameter, and retains that shape. It winds, and at first is level, but soon begins to slope. The ground is strewn with small bones and teeth. It seems to lead to the space whither flows the water from the last described room, but as yet it has been explored for only a distance of about 100 feet.

8. An eighth passage is about 6 feet wide at the opening and 3½ feet high. It gradually increases in height until, at a distance of 40 feet from the beginning, it is six feet high. Up to that point it is level; but now it descends and widens, the roof remaining level, until at a distance of 140 feet from the beginning, it is 12 feet wide and 40 feet high. The ground is granite and red clay. The passage ends in a room called the

BLOW ROOM,

after whilom Hon. Henry T. Blow, of St. Louis, who in 1869 penetrated thus far and chiseled his name in the wall. The Blow Room is about 100 feet wide, 250 feet long, and 100 feet high. The floor, also granite and red clay, is level in the center, but slopes both ways. On one side is a hole 40 feet wide, opening upon a precipice 130 feet deep. At the opposite side is a round shaft, six feet across, partly covered by a great slab of rock. This shaft is 32 feet deep. It ends in the roof of a nearly level passage, about 10 feet high and 6 feet wide.

After having followed this passage in one direction for 40 to 50 rods, one crosses a stream of clear water, about 10 feet wide and one foot deep. The passage then widens and becomes the canyon of the stream, which one has to cross and recross. Occasionally it gets lower, so that one has to creep. From time to time it expands into rooms, none over 20 feet high, 20 feet wide, and varying in length from 30 to 50 feet. This passage has been followed for a distance of two miles, and upward of 20 rooms have been passed. It is tortuous, monotonous, has no water formations on walls or roof, descends with the rapid current of the stream, and has in some places a rough and in others a slippery floor. The rock is granite of beautiful colors and of a high degree of fineness. The emery rock already mentioned also shows itself in some places. The passage might be followed farther; but has not been yet, from lack of time. Bats are still occasionally found. Some guano, but not in beds; probably the water mostly carried it off. Following from the bottom of the shaft the same passage in an opposite direction, one descends more than when moving the other way. It winds round, and while it continues (about which more anon) soon therefrom branches off another passage. This traverse four rooms in succession, and ends by reaching the bottom of the precipice, first seen from the great gap in the wall of the Blow Room. The four rooms average about 20 feet in height, and vary in width from 10 to 25 feet and in length from 30 to 60 feet. Three have projecting ledges running all round along the sides, interrupted only by the openings of the passage. One can walk over those ledges as in a gallery. The floors slant, and are, as well as the walls and roof, of granite and yellow and variegated marble. Very little guano. Here and there are holes in the floor, showing underneath similar rooms of less height. In these lower rooms are several small swift streams of very clear water, running in different directions.

The room constituting the precipice is 230 feet high, nearly circular, and 75 feet in diameter. It is called the

VOICE ROOM,

because frequently sounds are heard there so strikingly resembling human voices that an explorer, on first entering it, drew a revolver in self-defense. Probably they are echoes of falling water, and depend on the rush. The lower part of the Voice Room is emery rock, the upper part granite, between which two the top of the precipice, or level of the Blow Room, is about the dividing line. Opposite the passage through which one has entered is a kite-shaped crack in the wall. This crack runs up about 20 feet. Near the top it is about 20 feet wide, and at the bottom the sides close together in a point. It is the entrance of an almost straight passage which retains that shape, and first descends, at an angle of 45 degrees, but later becomes a little less steep. The crack grows larger at the top and higher, till it reaches sixty-five feet in height, and, near the top, 40 in width; but at the bottom it always remains coming to a point. Here and there in that bottom are holes affording a view of rooms below, to a depth of about 30 feet. It is all emery rock; no other rock is any longer met with. It leads into what is called the

WATERFALL ROOM.

This room is crescent shaped, and about 100 feet high. One enters it at one of the corners of the crescent. From there to the opposite corner is about 200 feet. About the center it is 30 feet wide. Near this center, about the middle of the outer line of the crescent, is a recess in the shape of a horseshoe. The two points of the horseshoe are 50 feet apart, and the curved line between is 125 feet. The wall of this recess is perpendicular, and 60 feet high. Down it falls, with great force, a large body of water coming from rooms above. One can pass behind the fall, between it and the wall. The spray in such as to extinguish, anywhere in front, a light not protected by a lantern. The entire floor of the Waterfall Room is covered with beautiful water formations, resembling the figures on a carpet, but standing out in relief. The walls are similarly covered, the formations looking like pails, baskets, etc. In the front of the fall are jug-shaped basins, varying in depth from 1 to 2½ feet, and in width from 6 inches to 3 feet, with openings only big enough for the insertion of the hand. The water streams in them, and probably passes out again through small cracks, which matter however has not yet been ascertained, nor what becomes of the water. These basins contain white, soft, blind, toothless lizards, from 2 to 6 inches in length. The roar of the waterfall, and of other falls below not yet reached, is such as to render conversation in any portion of the room impracticable.

At the opposite corner of the crescent is an ascending passage about 4 feet wide. The roof of this passage is a continuation of that of the Waterfall Room. The floor is of red clay, very slippery, into which steps must be cut, as the angle is 45 degrees. The passage is nearly straight, and about 100 feet long. It ends in a room 60 ft. above the level of the floor of the Waterfall Room. This room, which one enters by a turn to the left, is about 10 feet high. It contains one large spring and a cluster of smaller ones. In a backward direction it is connected by a passage about 40 feet long and 4 ft. in height and width with a similar room, also containing springs. This second room is, by a similar passage, about 20 feet long, connected with a third room of the same kind. The two first rooms are about of a size, but the third is smaller. The third room contains the head of the waterfall; and the springs in the rooms last mentioned furnish a portion of the water. These rooms and the connecting passages are together between 300 and 400 feet long. The rooms are about 35 feet in width. From the first and second rooms, passages lead to other rooms beyond, but these have not been explored. Water also flows from those unknown farther rooms.

The waterfall is fed, not only by the springs above described, but also by a swift, shallow stream, about 30 feet wide, coming through a low canyon. This canyon has been ascended for a distance of about 700 feet, and might be farther explored. The entrances to 10 passages, all but one ascending, and with water running through them, were passed. Half of these passages are on one side and the balance on the other of the canyon, at very irregular intervals. They have not been examined except the second to the left, which descends, and is dry. That passage is about 8 feet wide and 4 feet in height. Its entrance is dammed by rock and water formations. The passage gradually increases in height until it reaches 10 feet. It winds, and is about 200 feet long. It opens on a semicircular room. The descent to that room is very slight. The room is over 60 feet high; greatest width, 20 feet; length of outer curve, 250 feet. The walls are emery rock and red clay; preponderance of red clay. About ⅔ of the floor is covered with a thick layer of fine guano. The uncovered balance shows the red clay. The entrance is at one end. At the opposite end the wall does not go clear to the top, but runs up to a height of 30 feet. It is a heavy bank of red clay, studded all over with pointed pieces of mica, of about the length of a finger, glittering like diamonds and soft enough for chewing. About the middle of the outer curve, 30 feet above the floor, in the outer circular side, is a hole, about 6 feet in height and 4 feet in width, the entrance of a passage about 20 feet in length, which ends at a precipice of unexplored size. Rocks thrown down that precipice are heard to strike the bottom in the time required to count 21.

Near the clay wall is a winding and gently descending passage, about 4 feet wide and from 5 to 10 feet high. It leads in succession to three rooms, which average 20 feet in height and 12 feet in width, and are semicircular and with arched roofs. In length they vary from 30 to 50 feet. Some guano, but no great quantity. Passage and rooms together about 300 feet long, with emery rock

and red clay. This passage, always descending, ends in the one which passes the foot of the Blow Room shaft. The point of junction is 200 feet from the bottom of the shaft. Between these two points is the entrance of the passage taken when going toward the Voice Room, so that a circuit has been made. The passage in the roof of which the shaft ends continues beyond the point of junction just described, but has not been farther explored.

This entire part of the inside of Roark Mountain is one vast labyrinth of

CAVES AND PASSAGES,

the one above the other, and as yet only partly known.

9. A ninth passage has its entrance 15 feet above the bottom of the cave. That opening is wedge-shaped; the base is 3 feet, and the sides come together at a height of 10 feet. The passage retains that shape. It is level and smooth at the bottom, but the sides are rough, and only a small sized person can enter. This passage is 60 feet long. It leads to and ends in a small triangular room. The floor of the room is an isosceles triangle, each side 20 feet. The roof is pyramidal, and about 50 feet high. From the top stalactites clear as crystal, from one to 5 feet long, hang down. The sides are covered with crystals of translucent onyx. On the bottom is but little guano, as the bats seem to prefer smoother roofs and larger rooms. Water formations so completely incrust the walls that the nature of the rock has not been ascertained.

10. A tenth passage is a crack in the wall of the cave, near the point where the foot of the cone-shaped pile comes closest to that wall. The crack is wedge-shaped and 70 feet high and 3 feet wide at the bottom, the sides coming together at the top. The passage thus made is rough from protruding flints, and descends at an angle of 45 degrees, until, at a distance of 60 feet from the starting point, it is intersected by a precipice 46 feet deep. Across the precipice, leaving a gap of about six feet, is a projecting ledge about two feet thick. The passage continues across this ledge, but becomes much narrower, and has not been farther examined. Descending down the precipice with a ladder, one finds an oblong room about 15 feet wide and 20 feet long. The top is on a line with that of the passage, except in so far as the projecting ledge mentioned intervenes. The bottom is very thickly covered with guano. Sides, perfectly plumb and as smooth as masonry, of dove-colored marble. In the wall under the ledge is a hole about 5 feet high and 3 feet wide, through rock 2 feet thick. This hole gives access to another similar room, the floor of which is on a level 20 feet lower. That room, too, is oblong. It is 15 feet wide, 20 feet long, and 25 feet high. Walls like those last described. In both these rooms the layer of guano which covers the floor is at least 10 feet thick, as with a pole of that length bottom could not be reached. The first of the rooms is called the

JONES ROOM,

after Dr. T. Hodge Jones, secretary of the cave company, who was the first to explore it. The second the

ARNOLD ROOM,

after F. D. W. Arnold, treasurer of the same company, for a similar reason.

11–15. Where the foot of the cone approaches closest to the wall of the cave is a recess in that wall. Five passages, all low and narrow, lead from that recess. They are about 3 feet high and from 3 to 4 wide, and slope gently downward. Each leads to a series of small rooms of irregular shape. Only nine of these rooms have been visited. Passages and rooms both have been but imperfectly explored. The rock in them, and even the recess of the cave, is of an alkaline nature and crumbling. Everywhere are loose stones and debris. The rock easily slakens and pulverizes. An acid causes it when pulverized to effervesce. The application of water hardens it into the likeness of plaster of Paris. The color is light gray. It has not been analyzed. No guano here. The bats avoid this place, probably because the rocks in the roof are apt to tumble down. This same circumstance has retarded more thorough exploration.

The temperature of the cave is 56 degrees Fahrenheit during the hottest season. It rises slightly in rooms and passages below. Whenever the weather is cool, a person sitting on the top of the cone at the foot of the ladder can see myriads of bats sweeping down the mouth of the cave.

The top of Roark Mountain, with its Marble Cave, is situate about the center of Section 29, Township 23, Rng 22. That section is owned by the Marble Cave Mining and Manufacturing Company of Lamar, Missouri, incorporated under the laws of Missouri on the 3d day of June, 1884. Forty acres on the level top of the mountain round the entrance to the cave have been platted, laid out in building lots, and dedicated. The branch of the St. Louis and San Francisco Railroad which now is in operation between North Springfield, Mo., and Chadwick, will, when continued into Arkansas, as surveyed and staked, pass within twelve miles from the cave. The newly laid out town may then become a popular place of resort for health and pleasure, as well as a center of business for the getting out and marketing of the millions of tons of guano, marble, onyx, emery, granite, and other valuable material hidden inside Roark Mountain.

The "Wilderness Road," a wagon road leading from Springfield, Mo., into Arkansas, passes within 4 miles from the cave. These 4 miles can be traveled over by a remarkably good natural road, with beautiful scenery all the way. Springfield is 40 miles from the point where this road strikes the Wilderness Road.

Forsythe, the head of navigation on White River, during the high water of spring, is 15 miles in a straight line from the cave. It is the county seat of Taney County. Galena, the county seat of Stone County, is also 15 miles off; and Ruth, distant 6 miles in the same county, is the nearest post office.

TO HARDEN CAST IRON.—Heat the iron to a cherry red, then sprinkle on it cyanide of potassium (a deadly poison), and heat it to a little above red, then dip. The end of a rod that had been treated in this way could not be cut with a file. Upon breaking off a piece about half an inch long, it was found that the hardening had penetrated to the interior, upon which the file made no more impression than upon the surface. The cyanide may be used to caseharden wrought iron.

NOTES ABOUT LYRE-BIRDS.*

By A. J. CAMPBELL.

"IN 1844, Mr. Hawdon, with a party of twelve able-bodied men, including black native police, was instructed by the Government to open up a practicable route for cattle from Western Port to Gippsland. It was while performing this journey that he had an opportunity of closely examining the shy and curious lyre-bird." This is an extract from "The Colonies of Australia," by Samuel Sidney, 1853, and is the oldest published data we possess respecting Queen Victoria's lyre-bird (*Menura Victoriæ*), named by Gould in honor of our Most Gracious Sovereign. This species is frequently and erroneously confounded with *Menura superba*, the New South Wales variety.

The oldest information possessed by me dates back to 1847, when a relative of mine commissioned a black fellow named McNabb (a somewhat aristocratic Caledonian name for an aboriginal of the Yarra Yarra tribe) to obtain some tail feathers. He was absent a few days and returned with five tails, which he procured on the river side of the Dandenong Ranges, and for which he received one shilling each.

Much has been said and written about lyre-birds, yet still comparatively little is known concerning their natural economy. This is principally due to its shy disposition and the almost inaccessibility of the tracts of country frequented by them. Its position in the great list of birds is very unique, and not only are the eyes of all Australian but of all the ornithologists of the civilized world directed toward the wonderful Menura.

I shall content myself in this paper by simply narrating a few facts hitherto unpublished or imperfectly known, which have been gathered from personal observation, or furnished by friends who have been favorably situated. Of course, my remarks refer to the Victorian variety, and are principally connected with its nidification.

Also by data hereinafter mentioned, I shall endeavor to move the club to memorialize the Honorable the Commissioner of Trade and Customs, the administrator of the "'Game Act," to take the necessary steps to extend the close season for lyre-birds, say from the first day of July, in lieu of the first August.

Their limits of locality extend from the Australian Alps and adjacent spurs southward through favorable tracts of country to the coast; but not further westward than the Plenty Ranges. Their food consists principally of beetles, centipedes, scorpions, worms, land-crabs, and snails, and occasionally something more solid, in the shape of bush mice.

Lyre-birds pair and build their nests about the middle of June or the beginning of July. Their single eggs are generally laid about the end of that month, but certainly not later than the first week in August. I knew of two instances of eggs taken in June. In three nests taken myself, the eggs were deposited about the beginning, middle, and end of July respectively, therefore, as far as the taking of eggs is concerned, one may drive the metaphorical "coach and four" through our "Game Act," which only protects these birds from the first of August.

The birds lay one egg a season. Twice I heard of two eggs in one nest.

As before mentioned, the pairing season is about June. At that period the males sing more than at any other time, and like human beings they don their best frills for courting, their somber plumage appearing very sleek, and their graceful tails are at their prime. When the female commences to incubate, and throughout that term, her mate ceases to sing so lustily, in fact, is almost silent. I believe both aid in the construction of the nest, but the female alone incubates. I possess no facts respecting the duration of that period, but should judge about twenty-one to twenty-eight days.

Nests are usually placed near the ground in thick scrub, in valleys or gullies, as well as on ridges and more level country, but generally in the neighborhood of ferns and fern trees. A favorite position is at a butt or in a fork or elbow of a convenient tree, or on leaning fern-tree trunks, or not unfrequently in the hollow stump of a high gum tree that has been snapped off by some gale.

The inner or proper nest is constr[illegible]d of the dark-brown wiry, and fibrous material o[illegible] ree-fern trunks and other fern rootlets closely matted together and interwoven with stringy leaves, moss, sand, etc., the inside bottom being lined with the bird's own breast feathers. It is oval, about twice the size and same shape as a modern football, with an end lopped off, which serves for a rounded side entrance. This inner nest is embedded in an anterior or outer nest composed of large sticks and twigs, resembling that of an eagle's, with spouted platform of landing place at the entrance. The roof of the inner nest is also protected with sticks, and over the whole structure are often artfully thrown a few dead or green fronds and other vegetation.

The dimensions of different nests do not vary much. The following are sizes of one which I took on the spot. It was situated in a gully on a slight eminence, consisting of a fallen tree-fern trunk with other *debris*. So cunningly was it laid that it was undiscoverable from behind to a person not two paces off; but the front, which betrayed it, commanded a good out-look down hill. Over all, height, breadth, and depth, were 2 feet each way; through diameters (*i. e.*, length and breadth) of interior nest, 1 foot 3 inches and 1 foot respectively; entrance, 6 inches across; inside or egg cavity, from wall to wall, and from roof to floor, 10 inches each way, and from entrance to back wall, 1 foot 1 inch. The ragged spouted platform or landing place extended 5 or 6 inches beyond the entrance.

The egg, which was hidden by the feathers, lay at right angles with the entrance, and measured 2 inches 5 lines by 1 inch 8 lines. The egg was of the usual color, purplish-gray, mottled with spots and blotches of a darker color.

The female doubles her tail over her back, and enters backward into the nest. When securely settled, only her head and tail-tips are visible at the entrance. When incubating, her mate keeps away.

I could never find evidence of the birds reconstructing their old nests as mentioned by Mr. F. J. Williams in his instructive paper, "The Habits of the Lyre-Bird," read before the Club, February, 1881. Mr. Williams also states that on going to roost at night "they choose a secluded spot sheltered from the wind, and mostly in a low tree." My observations are the reverse of this. About dusk I have watched them, till I almost lost their form, fly more than 100 feet up to the thick branches of some great forest patriarch. They ascend by a succession of leaps and short flights, from bough to bough, and from tree to tree, always surveying the position after each move. I also know for a fact that birds have been watched coming out of gullies to roost on large dead trees of the ridges, where they have been shot. In roosting they do not congregate. Sometimes during moonlight seasons a cock bird from his elevated perch agreeably disturbs the midnight stillness of the forest by his delightful shrill whistle.

The powerful sonorous ring of the lyre-bird's natural song is not surpassed by any of its Australian compeers; as to its mocking capabilities, it certainly leaves all the world's mocking birds far behind. Its ear is so accurate that it can imitate to the very semitone the vocality of any of its forest friends, whether the solemn "mo-poke" of the owl, the coarse, laugh-like notes of the great brown kingfisher, or the higher pitched and more subdued notes of smaller birds. But the most extraordinary performance is the imitating, not a single bird, but a flock; therefore it has to produce duplex or double-sounding notes. I have heard it imitate simultaneous sounds exactly like the voices of a flock of Pennant's parrakeets rising from the scrub. It is equally at home with other familiar forest sounds, the grunting of the koala or native bear, the barking of the selector's dog, the noise of the splitter's saw, the clinking of his ax against the metal wedge, all alike are perfectly reproduced in the throat of this most singular feathered mimic. It may be yet proved that this bird is also an able ventriloquist. I am in possession of some scraps of information, yet not sufficient to warrant me stating facts here. The birds do not sing in windy weather, but in South Gippsland, where the mountain spurs terminate abruptly at the sea, and where the birds are found and breed within 50 or 100 yards of that element, it is most delightful to hear their pure liquid songs above the booming of everlasting ocean billows.

It should be mentioned that the cock bird only whistles and mocks; the hen does not, but her alarm and call notes are identical with her mate's. The alarm note is a short, shrill whistle, not unlike that produced by a person placing the tongue against the upper teeth after the fashion of the street Arabs. The call is a lower pitched double-note something like "beleck-beleck" or "bullan-bullan." Both sounds are aboriginal names of the lyre-bird.

Of course, it is known to nearly all that the male birds each possess several little mounds of earth on which they caper and jump about while pouring forth their songs, also proudly drooping their wings and displaying their elegant tails. But at times certain sounds are emitted and a peculiar action of the tail produced that have not yet been recorded. Between periods there comes from the throat a spasmodic buzzing or purring noise; at the same time, while the tail is expanded or reflected over the back, all the quills violently shiver.

My friend, Mr. Charles Chandler, of Malvern, informed me of an albino cock bird he twice noticed in the Bass River district. It sang most melodiously, and was a lovely creature. Its pure white plumage formed a wonderful contrast with the eyes, bill and legs, which were black. The tail was large, well formed, and of the usual color. I have also heard of spangled varieties from the same district.

I shall conclude at this time by stating two ludicrous legends respecting lyre-birds. One which has been published states that they are a species of thrush. The other is not an uncommon belief that they are remarkable pheasants, which whistle and produce music with their tails. The latter may be explained from the fact that all lyres are music-producing, and the two most conspicuous tail feathers are lyre-shaped, hence the name of the bird.

Through the generous assistance of a member of the club, Mr. N. J. Caire, landscape photographer, I have been greatly enabled to illustrate this paper by means of three handsomely executed pictures, viz., the haunt of the lyre-bird, situation of nest, and nest itself.

* Read before the Field Naturalists' Club of Victoria, Sept. 8, 1884.

GENERAL TRUTHS IN APPLIED ENTOMOLOGY.

By Prof. C. V. RILEY.*

Mr. President and Gentlemen of the Georgia State Agricultural Society:

ON your programme I am booked for an essay on "Insects Destructive to Southern Agriculture." Your worthy Secretary, Mr. Grier, is responsible for that title, for I had no idea what it was to be till the circular was received, on the very day of my departure from Washington. In the mean time, in pondering the question what to present to you, I concluded it were better, perhaps, to state some general truths of universal application than to attempt to treat of the different species of injurious insects which the members of this society must be interested in—coming, as they do, from all parts of a State with such vast and varied agricultural interests. Hence, the hasty notes which I shall present are not worthy to be called an essay, and if they must have a title, would better reflect some "General Truths in Applied Entomology." It will, however, afford me great pleasure at the close to give more specific information in answer to any questions that may be asked.

Insects play a most important part in the economy of nature. The average townsman, whose knowledge of them is confined to certain lectual and household pests, can scarcely appreciate the fact, or have any other feeling than repugnance and contempt for the annoying hexapods of his acquaintance. Yet, as scavengers, as pollenizers of our flowers and fruits, or as food for other animals, they not only vitally concern man, but, philosophically considered, are seen to be essential to his very existence.

We receive, also, some direct benefits from insects. They supply us with the sweetest of sweets, our very best inks and dyes, and our finest robes and tapers, to say nothing of various acids, lacs, and waxes; while few who have not studied the subject have any just idea of the importance of insects and their products as articles of human diet.

* An address delivered February 12, 1884, before the Georgia State Agricultural Society at its annual meeting in Savannah.

But the benefits, whether direct or indirect, which man derives from insects must always appear trifling compared to the injury they inflict on our agriculture.

In the primitive condition of the country, as the white man found it, insects, doubtless, took their proper place in nature's economy, and rarely preponderated in any direction to the injury of the wild plants scattered, for the most part, sparsely throughout their range. Harmony between organisms, in the sense of the widest interrelation and interdependence, had resulted in the long course of ages. But civilized man violated this primitive harmony. His agriculture, which is essentially the encouragement and cultivation, in large tracts, of one species of plant to the exclusion of others which he denominates weeds, gave exceptional facilities for the multiplication of such insects as naturally fed on such plants. In addition to this inevitable increase of species thus encouraged, many others have been unwittingly imported from other countries, chiefly through the instrumentality of commerce with those countries; for it is a most significant fact that the worst weeds and the worst insect pests of American agriculture are importations from Europe. Thus, in addition to the undue increase of our native species, as above noted, we have to contend with these introduced by foreigners, and it is no wonder that Dr. Fitch declared America to be the land of insects, for, as compared to Europe, we are truly bug-ridden.

As I have stated (Encyclopædia Americana, Agricultural Entomology): "The losses occasioned by insects injurious to agriculture in the United States are, in the aggregate, enormous, and have been variously estimated at from $300,000,000 to $400,000,000 annually. It will never be possible to fully protect our crops from the ravages of the many species that injuriously affect them; but it is the aim of the economic entomologist to prevent as much of the loss as possible and at the very least expense. To do so effectually, the chief knowledge required is of an entomological nature, *i. e.*, the full life history and habits of the different species; and this implies a great deal of close and accurate work in field and laboratory. By means of it we learn which species are beneficial and which are injurious; and the ability to distinguish between friend and foe is of the first importance in coping with the latter, for it a notorious fact that the farmer often does more harm than good by destroying the former in his blind efforts to save his crops.

A great deal has been written and published of late years on the subject of economic entomology, much of it, however, at second hand; for, unfortunately, the original workers are few. That comparatively small progress has hitherto been made is due to this last fact, as well as to the intricacies and complex nature of the subject. The economic entomologist, to do effectual work, must possess, not merely a knowledge of the particular injurious species, and its habits, with which he wishes to deal, but must study its relations to wild plants as well as to the particular cultivated crops it affects. He must also study it in its relations to other animals. Indeed, its whole environment must be considered, especially in connection with the farmer's wants, the natural checks which surround it, and the methods of culture that most affect it. The habits of birds, the nature and development of minute parasitic organisms, such as fungi, the bearing of meteorology, must all be considered, and yet, with the knowledge that a study of all these bearings implies, he will frequently fail of practical results without experiment and mechanical ingenuity."

The earlier writers on applied entomology, as Peck, Harris, Fitch, Walsh, Le Baron, Glover, did good work in unraveling the life mysteries of injurious species, and framed their advice to the cultivator from these entomographic studies. Mere study of this kind alone, however, while essential, is not often productive of those important practical results which follow when it is combined with field work and experiment by competent persons and upon scientific principles. Many of the remedies proposed and recommended in the agricultural press are either ridiculous or else based on misleading empiricism, and economic entomology, as a science, is of comparatively recent date.

The time limit of this paper will permit but the briefest reference, by way of illustration, to some of the means alluded to. I have already indicated the prime importance of a knowledge of the life history of the species to be dealt with—a knowledge that can come only by direct and careful inductive research carried on sometimes during many years; for every insect exists, in the course of its development, in four different states, three of them more or less abruptly marked by metamorphosis, and each with habit and environment peculiar to it. Thus the same species may inhabit earth, air, and water at one or the other period of life, and yet be quite incapable of a change of environment at any one period. It took me five years, with a number of observers at command, to definitely settle some points in the life history of the cotton-worm (*Aletia xylina*, Say), and with all the resources of the French Government—its liberal premium, its superior and sub-commissions appointed for the purpose and at work for the past fifteen years—there is much that is yet mooted in reference to the grape phylloxera. You have all heard of this insect, and perhaps a brief statement of its habits will serve to illustrate the complicated problems with which the economic entomologist often has to deal. I quote in substance from one of my reports:

"The full life history of the species exhibits to us no less than five different kinds of eggs. 1. The regularly ovoid egg, 0·25 mm. long and half that in diameter, of the normal, agamic, and apterous female, as it is found upon the roots. 2. The similar but somewhat smaller egg of the gall-inhabiting mother. 3. The female egg from the winged mother, rather more elliptical, and 0·4 mm. long when matured. 4. The male egg from same, ¼ less in length and rather stouter. 5. The impregnated egg, 0·23 mm. long, still more ellipsoidal, and with peculiar sculpture and anal point. We have also the peculiar spectacle of an egg from the winged mother increasing from 0·34 mm. (its size when laid) to 0·4 mm. (its size just before hatching), giving birth to a perfect insect 0·4 mm. long, and this without any nourishment, laying an egg 0·32 mm. long. A being thus born, and without food whatsoever, lays an egg very nearly as large as that from which she came.

"We have, further, the spectacle of an underground insect possessing the power of existence even when confined to its subterranean retreats. It spreads in the wingless state from vine to vine, and from vineyard to vineyard, when these are adjacent, either through passages in the ground itself or over the surface; at the same time it is able in the winged condition to migrate to much more distant points."

The recent advance in our knowledge of the life history and habits of species has been great, but leaves yet an immense field for future research.

Insects probably outnumber in species all other animals combined, some 350,000 having been already described, and fully as many more remaining yet to be characterized. The proper and conscientious characterization of a genus or species of some microscopic creature involves as much labor as that of one of the higher animals. Of the above number a goodly proportion are injurious to cultivated crops. Lintner recently records no less than 176 affecting the apple.

Of insecticides any number of substances have been recommended, and many of them tried with more or less satisfaction. Of these may be mentioned lime, sulphur, soot, salt, wood ashes, corrosive sublimate, naphtha, naphthaline, turpentine, alum, carbolic acid, phenyle, cyanide of potassium, blue vitriol, ammonia, alkalies, benzine, vinegar, sulphuric acid, quassia, vitriol (the sulphate of copper), hot water, etc. Most of these may be successfully used for specific purposes, either dry, in liquid, or in vapor; but the three most useful insecticides of general application in use during the early days of economic entomology in this country, and up to within a few years, were undoubtedly tobacco, white hellebore, and soap. Tobacco water and tobacco smoke have long been employed against aphides and other delicate insects, and are most useful. A quite recent advance in its use is by vaporizing. The vapor of nicotine is most effectual in destroying insects wherever it can be confined, as in greenhouses. Thus the boiling of tobacco in such a greenhouse is as effectual as and less injurious to the plants than the older methods of syringing a decoction or of fumigation by burning; while experience by Mr. William Saunders, at the Department of Agriculture during the past two summers, shows that the vapor gradually arising from tobacco stems strewn on the ground and regularly moistened is likewise effectual.

White hellebore, either dry or in liquid, has long been one of the most satisfactory insecticides against Tenthredinid larvæ, otherwise known as false caterpillars, of which the imported currant worm (*Nematus ventricosus*) is a familiar type; while soap, syringed in strong suds, will kill some soft-bodied plant destroyers, and when used as a paint on the trunks of trees is an excellent repellent against the parents of different borers.

Transcending in importance, however, any of these older insecticides are the three now most commonly used because most satisfactory. They are: (1) arsenical compounds, (2) petroleum, and (3) pyrethrum. The first act through the stomach, and are effectual chiefly against mandibular insects; the second and third act by contact, and are, therefore, of more general application, affecting both mandibular and haustellate species.

The use of arsenic as an insecticide in the field dates from the year 1871. At the rate of 50 grains of arseniate of soda and 200 grains of dextrine dissolved in a gallon of water, and this diluted at the rate of about an ounce to ten gallons of water, it furnishes one of the cheapest of insecticides at command, and various patented combinations of it have been extensively sold and used. Again, one pound of arsenic and one pound of sal-soda boiled in one gallon of water till the arsenic is dissolved, and diluted at the rate of one quart to forty gallons of water, is also a good formula. The chief merits of arsenic are cheapness and solubility. Its demerits are its white color, which makes it liable to be mistaken for harmless substances of the same color, and its tendency to burn the plant. Paris green or Scheele's green has been more extensively used than any other arsenical compound, and is, on the whole, one of the most satisfactory insecticides. I first used this poison against the Colorado potato beetle (*Doryphora 10-lineata*) in the summer of 1868, but, owing, doubtless, to the use of an inferior article, reported adversely upon it. (First Report on Insects of Missouri for 1868, p. 116.) George Liddle, Jr., of Fairplay, Wis., experimented with it the same summer, and with one part of the green to two of flour, found it eminently satisfactory (*American Entomologist*, i, p. 219), and from the time he announced his experience—May 25, 1869—in the Galena, Ill., *Gazette*, the green became rapidly popular against the Doryphora. I first recommended it in 1872 for the cotton worm, and its use gradually extended to other leaf-eating insects, until hundreds of tons have been sold for insecticide purposes in a single year. It is used dry with various diluents, as ashes, plaster, flour, etc., at the rate of one part of the green (if pure) to twenty-five up to one hundred parts of the diluent. Flour as a diluent has the great advantage of causing greater adhesiveness and permanence. In liquid suspension Paris green can be used at the rate of one pound to from forty up to one hundred gallons of water. The liquid should be kept constantly stirred, and a little dextrine or other substance added to give adhesiveness is an advantage.

A refuse obtained in the manufacture of aniline dyes, and known as "London purple," is the third important arsenical compound that I will mention in this connection. It consists of lime, arsenious acid, and carbonaceous matter, and was first used by me against the cotton worm and other insects in 1878, and more fully and thoroughly in 1879. It is used with diluents, either wet or dry, in the same manner as Paris green; while for some insects experience has shown it to be less satisfactory than Paris green, for many others it is equally effective, and has the great advantage over Paris green of being vastly cheaper (costing on an average but five cents against sixty cents per pound); of covering twice the ground, weight for weight; of being more soluble, less poisonous, more adhesive and permanent in its effects, and of decided color, so that when intelligently used it is in all ways preferable.

Petroleum, in its various forms, has long been recognized as one of the most effective insecticides in our possession, all oily substances being particularly deadly to insects. Unfortunately, they are also injurious to plants, and one of the problems the solution of which I have had in mind for many years has been their use in such dilution as to kill the insect without injury to the plant. Refined kerosene has been used to a limited degree, by forcible attenuation in water and spray, while some plants withstand doses of the pure oil. But the safe and general use of kerosene for the purpose under consideration dates from the year 1880. Of the various substances used in attempts to emulsify and mix kerosene with water, none are more satisfactory than soap and milk, both being everywhere accessible and cheap. Milk was first suggested in 1880, by Dr. W. S. Barnard, while carrying on experiments for me against the cotton worm, and subsequent experiment, especially by another of my assistants, Mr. H. G. Hubbard, has given us the simplest and most satisfactory method of making the emulsion quickly and permanently. An emulsion resembling butter can be produced in a few minutes by churning with a force pump two parts of kerosene and one part of sour milk in a pail. The liquids should be at about blood heat. This emulsion may be diluted with twelve or more parts of water to one part of emulsion, thoroughly mixed, and may be applied with the force pump, a spray nozzle, or with a strong garden syringe. The strength of the dilution must vary according to the nature of the insect to be dealt with, as well as to the nature of the plant; but finely sprayed in twelve parts of the water to one of the emulsion, it will kill most insects without injury to the plant. An equally good emulsion may be made as follows:

Kerosene, 2 gallons; common soap, one-half pound; water, 1 gallon.

Heat the mixture of soap and water, and add it boiling hot to the kerosene. Churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream, which thickens on cooling, and adheres without oiliness to the surface of glass. Dilute with cold water before using, to the extent which experience will indicate is best.

The simplest discoveries are often the most valuable, and this discovery of so simple and available a means of diluting, *ad libitum*, oil with water is important and far-reaching in its practical application. It were foolish to detain you with details of the several directions in which it has proved of great benefit, and which are recorded in my recent writings, especially in the reports of the entomologist of the Department of Agriculture for 1881-82 and 1883, and in Bulletins 1 and 2 of the Entomological Division of that Department.

Pyrethrum roseum, a plant native to the Asiatic countries south of the Caucasus Mountains, and *Pyrethrum cinerariæfolium*, a native of Dalmatia, have long been known to possess insecticide properties, especially in the powder from the dried and pulverized flowers. The powder, sold under various names by druggists, was chiefly used against household pests, however, and though Mr. C. Willemot, as early as 1857, in France, and Mr. William Saunders, in 1879, in Canada, tried it in powder form on some that are injurious to plants, its importance as a field insecticide did not appear till in 1880, when, in prosecuting the work of the United States Entomological Commission, we discovered that it could be used in liquid solution. During the winter of 1880 and 1881, I succeeded in importing a large quantity of the seed of both species, and on behalf of the above-named commission, distributed it to a number of correspondents in various parts of the country with a view of establishing its cultivation. Since then large quantities have been distributed from the Department of Agriculture. Both species proved to be hardy throughout the greater portion of our country, and Mr. G. N. Mileo, of Stockton, Cal., has, for some years, cultivated *cinerariæfolium* quite extensively at great profit, the product being sold under the name of "Buhach." The insecticide property dwells in a volatile oil. It acts only by contact, and its action on many larvæ is marvelous, the smallest quantity in time paralyzing and ultimately killing. Its influence in the open air is evanescent, in which respect it is far inferior to the arsenical products; but being perfectly harmless to plants, it can frequently be used on vegetables where the more poisonous substances would be dangerous. Pyrethrum is supposed to have no effect on the higher animals, but that is a mistake, as my own recent experience is that the fumes in a closed room have a toxic influence, intensifying sleep and inducing stupor; while the experience of Prof. A. Graham Bell, with the powder copiously rubbed on a dog, showed that the animal was made sick and was affected in the locomotive organs very much as insects are. The wonderful influence of this powder on insects has led me to believe that it might prove useful as a disinfectant against fevers and various contagious diseases by destroying the microzoa and other micro-organisms or germs which are believed to produce such diseases. It should be tried for that purpose. It is remarkable that these two plants of all the many known species of the genus should alone possess the insecticide property.

Of all insecticides to be used against root-feeding or hypogean insects, naphthaline, sulpho-carbonate of potassium, and bisulphide of carbon are the chief. Dr. Ernst Fischer, in a recent work, has shown that naphthaline in crystal may be satisfactorily used underground, destroying by slow evaporation. But bisulphide of carbon still holds the first place in France against *Phylloxera vastatrix*. It is conveyed beneath the ground at the rate of one-half to one kilogramme per vine by special injectors, or by more complicated machinery drawn by horses. I believe that petroleum emulsions will supersede it as an underground insecticide, and prove to be the best we have, cheapness, safety, and efficiency considered. This glance at the chief insecticides now in use may convey some idea of the recent progress in this direction, but will convey no idea of the far greater number of substances, whether drawn from the animal, vegetal, or mineral kingdom, that have been experimented with and found wanting. After the discovery of a satisfactory insecticide, however, various important problems must be solved, and particularly how to apply it to the greatest advantage, having safety to man and stock, harmlessness to plant, and economy in mind. The solution of these points, and others that the peculiar habits of the insect to be controlled involve, brings us to the question of mechanical contrivances and appliances; for while much ingenuity has been exhibited in devising mechanical means of directly destroying noxious insects without insecticides, it is chiefly in the proper application of these last that the greatest mechanical advances have been made both in this country and in Europe.

Here, again, the subject is so vast that I cannot enter into details. One can form some idea of the recent activity in this direction by glancing at the figures in the first report of the United States Entomological Commission on the Rocky Mountain Locust, my

bulletin on the Cotton Worm, and other official publications. Perfection here, as in other kinds of mechanical appliances that aid man's progress in art and science, is usually the slow outgrowth of tedious trials. However brilliant the original theoretical conception, the practical details are almost always the result of sheer experiment and trial. Failures precede success. Yet success will usually follow in proportion as certain principles are kept in mind covering particular needs in special cases—principles deduced from entomological studies.

It will already have been gathered, from what has preceded, that the chief insecticides are applicable in liquid, and as liquids have an advantage over powders in field use, instruments for atomizing and distributing liquids constitute the most important part of insecticide machinery. The desiderata in a spray-nozzle are, ready regulation of the volume to be thrown; greatest atomizing power, with least tendency to clog; facility of cleansing, or ready separation of its component parts; cheapness; simplicity; and adjustability to any angle.

I will content myself with exhibiting one which meets perhaps more of these requirements than any other in use, and which works on a new principle applicable to many other purposes than that for which it was designed. It is what has been described and illustrated in my late official reports as the eddy or cyclone nozzle, and consists of a small circular chamber with two flat sides, one of them screwed on so as to be readily removed. Its principal feature consists in the inlet through which the liquid is forced being bored tangentially through its wall, so as to cause a rapid whirling or centrifugal motion of the liquid, which issues in a fume-shaped spray through a central outlet in the adjustable cap. The breadth or height, fineness or coarseness, of the spray, depends on certain details in the proportions of the parts, and especially of the central outlet. The nozzle originated at Selma, Ala., in the fall of 1880, while I was in the field, with my assistants, working at contrivances for the destruction of the cotton worm. In a discussion as to whether liquid forced tangentially into such a chamber would whirl or not, Dr. W. S. Barnard took the affirmative position, and experiments with a chamber improvised with two watch crystals, in which the motion of the liquid could be observed, proved the correctness of the theory. The final form of chamber adopted is the result of numberless experiments carried on by Dr. Barnard in my work, both for the United States Entomological Commission and the Department of Agriculture, and the different phases of its development may be seen by the various models which I have brought for your inspection.

THE VICTORIA REGIA AT CHERKLEY COURT.

THE VICTORIA REGIA.

EXTRAORDINARY success has attended the culture of this rare and wonderful water-plant in the gardens belonging to Abraham Dixon, Esq., this year, at Cherkley Court, Leatherhead. His magnificent plant, apart from the interest which must always belong to the Victoria as one of the wonders of the vegetable kingdom, has other claims to our notice by reason of the circumstances connected with the importation of the seed, and their sowing, and subsequent growth, until unusual perfection was attained on Mr. Dixon's own plan. It is also supposed that the Cherkley Court variety is distinct from that hitherto grown in this country, it being brighter in the rose tint of its flowers, and more robust in its constitution. This may well be; as, since M. D'Orbigny sent the first account of it with specimens from Corrientes on the Rio de la Plata to the Museum of Natural History in Paris in 1828, the descriptions of the different travelers who noted the plant seemed to point to the fact that there were distinct varieties of it; indeed, M. D'Orbigny in 1835, in this *Voyages dans l'Amerique Meridionale*, himself mentions one which he considered different from that previously seen by him. Be that as it may, it may safely be asserted that Mr. Dixon's plant of the last season was one of the finest in foliage and in flower that has ever been produced in this country. The seeds were obtained from a friend on the Lago Grande, one of those large sheets of water for which the River Amazon is remarkable, the one in question being about 1,000 miles up that river. On January 9, 1884, the seeds were planted directly into the soil in the heated tank, the usual method of sowing them in pots and afterward transplanting them being departed from, and with advantage, for on germinating the plant grew with great freedom, and increased rapidly in size and strength and without exhibiting that tardiness of growth which is usually the case after transplanting out of pots. On February 12 the first leaf appeared, and on May 1 five large leaves were developed, so rapid had been its progress. Since May from sixty-five to seventy leaves have been produced, many of them measuring 6 feet to 7 feet in diameter, and having the raised border to the leaf standing up 6 inches or more, and thus in this particular quite eclipsing the 2-inch high raised edge which one of the travelers records of a plant which he saw growing wild on the Parana. Reference to our illustration will serve to give a good idea of the marvelous strength of these leaves when in vigorous condition, as at Cherkley Court. The secret of their great buoyancy is to be found on the under side, where a wonderful provision of Nature for sustaining the gigantic leaves even in troubled waters is arranged along the entire system of ribs and nerves. Strong cellular structures, as in Euryale ferox, follow every nerve of the leaf, being thickest near the stalk and gradually tapering off to the edge of the blade, acting like continuous cork floats all along the ribs, the greatest sustaining power being placed exactly where most needed—near the leaf-stalk, so as the better to counteract or break the force coming from any sudden rise or fall of the water level. Indeed, the whole plant, from the root to the flower, is a study of Nature's engineering. Altogether about sixty immense blooms, some of them 11 inches in diameter, have been produced by the plants in 1884, the first one having opened on May 21, and the last on December 15. On first opening they are white, but at the end of the first day the center becomes pale pink, and after two days are completed the whole of the flower changes in two hours with an almost perceptible blush to clear rose-pink. During the whole of the time they are open they are delightfully fragrant. These data seem to prove that while but few gardens can boast of the luxury of a Victoria tank in their tropical house, and but still fewer of those who have it can claim to have made it such a success as Mr. Dixon has done with the aid of his diligent gardener, Mr. John Page, who is a plantsman of the old school, but fertile in invention, and well up to date in practice, very many of our gardens have spaces devoted to, and elaborate contrivances for, some less worthy plants than the Victoria regia. The Cherkley Court plant will be grown on for another year; already it has started into new and vigorous growth; but not content with these proofs of its vigor, it has secured its perpetuity by spontaneously produced seedlings which are now coming on well. The tank is heated by hot-water pipes to a minimum of 75° in winter, and 80° in summer. Our illustration shows Mr. Dixon's adaptation of an old contrivance for keeping the water moving without much waste. It consists of a trough divided in the middle, with sloping sides swung on a pivot, with a dripping tap just over it. Each half of the trough is alternately presented for filling. After the tap has dripped into the end under process of filling long enough to destroy its equilibrium it tips over, and thus brings the other end under to be filled and tipped over in a like manner. The disturbance caused by the fall of the water at regular intervals seems to be of much benefit to the plant, and greatly to be preferred to a steady flow, which would not agitate the water so much. In the side tanks in the Victoria house at Cherkley Court all the obtainable water lilies are well grown, and give their harvest of lovely white, crimson, yellow, and blue flowers, even yet being good in foliage, and N. dentata is still in bloom. Later on they will be removed from the water, and only just kept moist, like any other plant requiring rest, until the time comes round to start them anew. The Nelumbiums, as will be seen by the leaf in the hand of the youthful navigator of the Victoria leaf in our illustration, are very fine at Cherkley Court, where lovely white and pink varieties are grown, their beautiful flowers being succeeded by those curious capsules, like children's rattles, which contain the "Sacred Beans" of tradition. To such a size do the leaves grow here that they are often 30 inches across, and are borne on stalks 7 feet in height. There is a character about both leaves and flowers of Nelumbium which renders them pleasant objects wherever they may be. For the rest of the water-plants at Cherkley Court, it may be said that it would be difficult to name a cultivated species which would not be found there in superb condition, even the lovely blue Pontederia (Eichornea) azurea, which is reputed to be a very risky plant in winter, being there in the most vigorous condition. As a general embellishment to the house, festoons of Allamanda, Stephanotis, Bougainvillea, and other climbing plants run along the chains round the tanks and over the roof, and having a most charming effect.—*The Gardeners' Chronicle.*

EVERY one has observed that the men who accomplish the most never seem in a hurry, no matter how much they have to do. They are not troubled for lack of time, for they make the most of the minutes by working in a cool, clear, orderly, and methodical fashion, finishing each task properly, and not wasting their nervous force on trifles or expending it in bustle. They never complain of overwork.

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